GAS JOURNAL

LIGHT · HEAT · POWER · BYE-PRODUCTS

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PROPRIETORS: WALTER KING, LIMITED. OFFICE 11, BOLT COURT, FLEET ST., LONDON, E.C. 4.

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Editorial Notes.

Fuel.

At a time when the closest attention is being paid to proposals which seem likely in any way to improve the position of industry, a discussion of fuel problems must be admitted to be pre-eminently well placed. Not only are heat and power essential to industry, but in the vast majority of processes they vitally affect costs. Cheap power is required everywhere; and those who can offer it are public benefactors. In this matter, however, as in most others, "cheapness" is, of course, not necessarily synonymous with actual cost. Items such as convenience, cleanliness, and ease of control, though impossible to figure-out in the balance-sheet, may yet have an important bearing upon the question of whether or not a particular form of fuel, or power, is cheap. It is only after all the factors have been taken into account that one fuel, as compared with another, can definitely be described as cheap. On various points enlightenment is needed; and a number of new and improved processes, together with older and well-tried ones, are at hand for consideration.

It is in these circumstances that we hail with satisfaction the International World Power Conference on Fuel which during this week and next is in session at the Imperial Institute, South Kensington. "International" is a word which too often, when applied to exhibitions, conferences, &c., possesses only extremely limited application; but this cannot be said to be the case on this occasion. On the contrary, participation in the deliberations is world-wide in the broadest sense of the term; for in all no less than 48 countries are represented, while the work of preparing the papers has devolved upon the leading technical and industrial institutions of 20 countries. The result of this is that material of an authoritative nature has been furnished for an international survey of the main tendencies, in both research and development, which govern the treatment and consumption of fuels. The papers submitted to the conference number between 170 and 180; and a feature that will be noted in connection with them is that, in general, under the title and the author's name, there is inserted the name or names of the authoritative body or bodies under whose auspices the contribution has been prepared. In a number of instances the name of The Institution of Gas Engineers appears as one of these bodies; and many other world-known organizations are also included. In numerous directions notable development is reported, and suggestions are put forward which should be fruitful of good in the future.

The World Power Conference on Fuel contains so much that is of vital import to the gas industry, that for this and two or three succeeding weeks we shall devote a great proportion of available space to the proceedings. The sections in the present number—those dealing with the Carbonization Industries—embrace papers by men whose opinions carry great weight on the particular subjects which they discuss; and therefore, within our limits, the main portions of these communications have been reproduced. Valuable, however, as the papers will undoubtedly prove, it would, consequent upon the excellent method of procedure mapped-out by the organizers of the conference, be in no way surprising should the discussions equal, or even surpass, them in importance. It will be seen on reference to later pages of this issue that nearly a dozen of the papers are published, either practically *in extenso* or in abstract; but this is by no means the whole story. At the different sessions none of the actual papers is to be read; but instead of this there is being presented a general report upon the group of papers that is to come up for discussion at that particular session. Thus, in addition to the papers already referred to, we publish to-day two of these general reports, which, in a space of from seven to eight columns, discuss the scope of the papers and the trend of development, and bring out important features which afford material for discussion. At the close of the reports is an agenda which is intended to cover the outstanding features, in the group of papers dealt with, which may be worthy of debate. This is a plan of action which will be followed with interest, as being something of a departure from custom. As stated in a previous issue of the "Journal," the arrangement appears to offer the only sound solution of the problem of preventing the business of the sessions becoming merely the reading of lengthy summaries by the various authors. We hope the conference will be productive of the utmost measure of benefit to all concerned. Certainly the organizers have deserved success.

A Timely Report.

There could not conceivably have been a more opportune moment than the days preceding the opening of the World Power Conference on Fuel for the publication of a report by a Committee appointed to consider and advise on questions connected with the economic use of fuels and their conversion into various forms of energy, having regard to national and industrial requirements, and in the light of technical developments. Here would be a most fitting contribution to the subject-matter of such a conference; and those who participate in the proceedings are to be congratulated upon the fact that they will have such a report before them. The National Fuel and Power Committee, who were appointed in August, 1926 (with Lord Melchett as Chairman, and, among others, Sir David Milne-Watson, Sir Arthur Duckham, and Mr. Frank Hodges as members), to consider the questions just indicated, at the end of last week published a first report which surveys generally the directions in which work is already being carried out for the promotion of economy and efficiency in the use of fuel, and puts forward a series of suggestions in relation to future activities. As the considered opinion of men qualified to give it, the report has a right to the earnest consideration of those to whom it is addressed; and its issue synchronizing with the holding of the World

Power Fuel Conference, makes doubly sure that it will receive this consideration.

There are a number of recommendations; and it will be seen that the Committee place early in the list those which have for their object the securing of co-operation. New words are continually being coined to meet new emergencies; but older words do not lose their appeal on this account, and we have yet to find a better word than "co-operation" to express the greatest need of industry to-day. Never could there have been a time of greater applicability than now of the well-known warning of the robber chief to his followers, when he said to them: "If "we do not hang together, we shall hang separately." The basis of every scheme to put our industries into the position which it is felt they should occupy, must be co-operation; and it is to be hoped that this need will not for a moment be lost sight of until it has been met to the fullest possible extent in every direction. Then we come to a recommendation to large consumers to pay more attention to the system of buying and selling coal to a specification, and another to district coalowners' associations to consider, in conjunction with the Electricity Commissioners, in what way local collieries can take part in electricity development.

In specific references to the gas industry, we again come across the important word "co-operation." The Committee, after pointing out that the general character of the carbonization process in gas-works and coke ovens is very similar, but that the differing objects of the two have caused them in practice to develop into two almost entirely separate industries, say: "We are doubt-"ful if so pronounced a separation of these two closely "allied industries has been entirely advantageous, and are "of opinion that it would be desirable for them in many "cases to have closer co-operation." This is a question that is having full consideration in a paper submitted to the Fuel Conference, which is commented upon in a subsequent "Editorial Note." By a coincidence, there will be found in another part of this issue of the "JOURNAL" an article on the Ruhr long-distance transmission scheme, to which reference is made by the Committee; and this article will be studied with peculiar interest in connection with the report. The Committee recognize that what is good for Germany in this respect must not necessarily be taken to be equally applicable to this country; but they make a recommendation that is to be welcomed, if only for the assistance which, if carried into effect, it must offer in deciding a matter of policy that is at the present moment the subject of keen controversy. In effect, it may have momentous results. The Committee say: "The "Government should undertake an investigation in rela-"tion to a limited area—such as that lying between the "Humber and Liverpool and between Leeds and Birming-"ham—of the technical and economic aspects of an area "gas supply system comprising an interconnecting net-"work of pipelines fed by a number of gas-works, coke "ovens, and the like."

They suggest the formation of a small Committee of qualified persons working in consultation with the National Fuel and Power Committee and provided with the necessary paid staff to make detailed investigations of this matter. This small Committee ought, they say, in the course of a year, to produce preliminary results of such value as to enable a decision to be made as to whether it would be worth while to proceed with the investigation. The cost of the preliminary work, it is mentioned, should not exceed £10,000. Speaking at the conference banquet on Monday night, the President of the Board of Trade (Sir Philip Cunliffe-Lister) expressed the view that this is an inquiry well worth instituting, and declared that he was there that night to tell them that the Government propose to undertake such an inquiry at once. In this regard he made, as will be seen from our report of the speeches on another page, an appeal for assistance in the matter of the staff to conduct the inquiry. This we feel confident will not fall upon deaf ears.

There are various other matters dealt with; but we must content ourselves here with expressing satisfaction at the acknowledgment made by the Committee of the fact that "the gas industry as a whole is now, within the limits within which it is confined by Statute, a progressive and efficient industry." The reservation "within the limits within which it is confined by Statute" will be noted. Do the Committee believe, as the gas industry itself believes, that, unconfined within these limits, the industry would be an even more progressive and efficient one? We are moved to ask this question, as reading through the report we have failed to find any reference to the gas industry's proposals for new legislation, which, as was stated by Sir David Milne-Watson at the last annual meeting of the National Gas Council, had been remitted by the Government to the National Fuel and Power Committee.

Our Industry and Coke Oven Gas.

As is indicated in the foregoing, the question of the purchase and distribution of coke oven gas is one of many facets, and hasty or dogmatic conclusions are manifestly absurd. The situation, moreover, is aggravated by the vast amount of exaggerated Press publicity—not always disinterested—both in this country and on the Continent regarding long-distance supply of surplus coke oven gas; and there is definite danger that the British public will be led to believe that conditions which are applicable to Germany apply with equal force here, whereas, in fact, they are in no way comparable. It was natural that the subject should come up for discussion at the World Power Fuel Conference; and our issue to-day contains two papers on the utilization of coke oven gas by the gas industry—one by Mr. T. P. Ridley, and the other by Messrs. C. P. Finn and R. Ray. In addition to these highly interesting contributions, we publish a remarkable review of the situation which has been set up in Germany as a result of the Ruhr coke oven gas scheme. This particular matter is the subject of comment in a later "Editorial Note" to-day.

Let us for a moment contrast the conditions existing in Germany with those operating in this country. In Germany the gas industry is smaller and the coke oven industry larger than in Great Britain, where gas prices are lower and the consumption per head of population very much higher. In the former country the coal and iron interests are closely interwoven, and exert great power both in political circles and in the Press—power which is being used to mould public opinion on sentimental and "national" grounds as well as on strictly scientific and economic principles. The domestic gas consumer, in fact, may in some cases become a pawn in a gigantic enterprise which, among other things, aims to cut-out import of British coal. Another point to remember is that in Great Britain the majority of the coke ovens are associated with collieries, while in Germany they are for the most part in close proximity to large steel works. Moreover, the gas industry here has progressed enormously since 1913, in regard not only to sales of gas, but also to plant equipment and efficiency of carbonization—a fact which was emphasized at the conference by Prof. J. W. Cobb, in his paper on gas manufacture. On the other hand, it must be admitted that the coke oven industry in this country has not on the whole progressed in like fashion, due to the depression in the iron and steel industry.

The coke oven owners maintain that it is impossible for them to contemplate the cost of reconstruction of their plant unless they can sell the greater quantity of the surplus gas which will be available after reconstruction. This, to us, appears a sensible argument if it is intended that the new plants shall, as before, be at the pit-head. But we share the view of Prof. Bone and Prof. Louis that they should be erected next to the steel works—that lean gas should be employed to heat the settings, and that the rich gas made in the ovens should be used in open hearth furnaces and for the production of power via engines. The contribution of Messrs. Finn and Ray provides plenty of support that cheap electricity can be generated from surplus coke oven gas. These authors cite an example of a 600-H.P. straight six-cylinder engine generating current at 0·166d. per unit, taking into consideration all working costs, maintenance charges, and depreciation. As for the employment of coke oven gas in open hearth furnaces, while we realize that many in this country re-

gard it in an unfavourable light, we know, too, of a large concern in the United States where the system is operated to very great advantage. This is at the Clairton plant of the Carnegie Steel Trust. Here the coke ovens carbonize 30,000 tons of coal a day—a quantity far in excess of that dealt with daily at the Beckton Works of the Gas Light and Coke Company, the largest gas-works in the world. The amount of gas available for disposal is no less than 200 million c.ft. a day, double the combined daily make of coal gas and carburetted water gas at Beckton; and the whole of this is employed in open hearth furnaces.

Co-Operation and Development.

THOUGH we think that the place for the coke oven is adjacent to the steel works—that only in this way will the nation reap the greatest economic advantage—we understand also that there may be circumstances which demand that the gas industry would be well advised, in the broadest sense, to purchase surplus coke oven gas. It is essential, however, that each case should be surveyed on its own merits. In America, for instance, a coke oven plant is ready to be put into operation at Newhaven. This plant is on the seaboard, and the coal is shipped 300 miles. The whole of the surplus gas in this case is to be pumped a distance of eighty miles for the supply to Newhaven and Hartford and smaller towns en route. The fact that this scheme may be successful, however, does not constitute an argument that similar enterprise would be rewarded in this country, for in America not only is capital cheaper and more plentiful, but labour is relatively expensive. The extent of capital outlay on mechanical equipment, with a view to eliminating labour as far as possible, has a different significance over here; and one becomes a trifle weary of hastily prepared and equally readily assimilated Press articles which endeavour to point out that Great Britain is behind other countries in respect of fuel problems. We are in complete agreement with Mr. Ridley that it does not seem advisable in the national interest to encourage sudden and grandiose schemes for the general utilization of coke oven gas in any particular direction. It is far better that it should be developed gradually on economic lines, as suggested by the National Fuel and Power Committee, in regard to limited areas.

Co-operation between the gas industry and the coke oven industry is essential; and narrow prejudice on the part of either industry must not be allowed to interfere with the solution of the present problem, and thus with the ultimate benefit of the public. It appears to us, however, that the coke oven industry hardly appreciates the obligations under which the gas industry labours; and because of this, we trust that Mr. Ridley's contribution to the conference will be studied by the former industry as well as by our own. When a gas undertaking arranges to buy and distribute coke oven gas, he remarks, there are many considerations to take into account. There is, first of all, the possibility of failure of supply. Then there is the far greater dependance on labour; stocks of coal have to be maintained either at the gas-works or at the coking plant, or at both; and the gas undertaking must provide, and keep in working order, stand-by plant for immediate use in emergency. With regard to the price which a gas concern can afford to pay, this must be determined by the nature of the supply—whether it is constant throughout the year, or whether it is merely to cope with peak-load demands. Finally, in drawing-up an agreement, it should be borne in mind that the efficiency of gas-works practice is likely to increase; and due allowance ought to be made for this. All Mr. Ridley's statements emphasize the futility of a flat price, even in the same district.

We close this article with three observations. The first relates to the statement made by Messrs. Finn and Ray that, granted the relaxation of certain Home Office regulations, "a vast supply of crude coke oven gas could be placed at the disposal of manufacturers at a figure which would be profitable to all concerned." We would compare this with the following quotation from Mr. Ridley's contribution: "With regard to the sale of unpurified gas, "after taking into account the low cost of purification and "the cost of special mains and storage which would be "necessary, it does not appear to be worth while in this "country to develop the sale of unpurified gas as against "purified gas. Many town gas undertakings have had "powers for years to supply crude gas, but in no case has "it been found worth while to exercise the power." Our second observation is that by next year there will be sold to gas undertakings in England as much coke oven gas as is at present being sold to gas concerns by the coke ovens under the Ruhr scheme of long-distance supply. And finally, there is no gainsaying the fact that already there is a world over-production of coke.

The German Gas Industry at Bay.

IN the last two years the German gas industry has been precipitated into a struggle for its very existence. Up to quite recent times, the gas-works were making a splendid recovery from the after-effects of the war, and from the period during which dirt and stones, with coal substitutes such as lignite and even wood, formed a large proportion of their carbonizing material. The struggle from which the industry had so recently emerged was soon to be followed by another, and it was early last year that the Ruhr coke-oven scheme first attracted the world's attention. So gigantic was it in conception; to such unheard-of distances, in such quantities, and under such pressures, was gas to be delivered from the coke-ovens of the Ruhr coalfield, that it bore the stamp rather of the flat-catching prospectus writer than of a serious practicable proposition. But that the promoters had both convictions and the courage to go on with them soon became clear, and our contributor of the review of the present situation in Germany shows the progress that is being made, and the methods by which they are making it.

We hear a great deal nowadays of the power of propaganda properly handled, and our readers will find a most interesting example in the article referred to. An attempt is being made, apparently with a considerable measure of success, to create general dissatisfaction with the present gas supply, and to persuade the nation to give gas manufacture in future into the hands of powerful interests who already control most of the coal, iron, and steel, and to a large extent liquid fuels. With gas they could, of course, obtain a monopoly of coke, and there would be little, we imagine, of Germany that would not have to dance to their tune.

As we read the situation, the nation may be saved from such a calamity by the fact that other coalfields, which are outside the combine, are competing with the Ruhr, and are determined to have their share of the plunder. Meantime, in order to get a footing, each group offers gas at a lower price than the other, and the gas undertakings are hard put to it to maintain the struggle.

Can we visualize such a situation in this country? Can we see the coking coal deposits of Durham piping gas to London for distribution through the existing great gas companies, with the manufacturing plant of these lying idle? In Germany, of course, the way has been easier for several reasons. To begin with, the great coal-iron-steel combine has long been in existence, and, as previously mentioned, it wields great political, as well as financial, power. There are certainly allied coal and iron interests in North-East England, but nothing in any way comparable with the Ruhr combine. Then the German gas industry is not so well qualified to defend itself against attack as ours, in that it is to a very much greater extent municipally owned. Gas companies in Germany are comparatively few in number, so that the element of the shareholder protecting his own is largely absent.

We agree with our correspondent that the gas industry in Germany is deserving of every sympathy in its struggle against tremendous odds. Its plea for survival appears fully justified. It numbers in its ranks many eminent men, who are fully capable of serving the best interests of the country, and of continuing the services which it has rendered in the past to the science and practice of gas manufacture and gas supply.

Economics of Ammonia Recovery.

COMMENTING on the paper on the manufacture of sulphate of ammonia in gas-works, which Mr. George Braidwood presented at the annual meeting of the North British Association of Gas Managers, we suggested in the "JOURNAL" a fortnight ago that "the small undertakings might do well to concentrate on the production of a strong liquor for transport to a central works where full advantage could be taken of large-scale operation and new processes." This idea tallies with that expressed by Mr. P. Parrish in a paper on this subject before the World Power Fuel Conference. He believes that the recovery of ammonia at the majority of works should proceed only to a certain point, and that its final treatment should be carried out at a number of centrally situated chemical works. In what form the ammonia ought to be transported is largely a matter of opinion and circumstance. Some think that concentrated gas liquor should be produced; others take the view that the intermediate product should be concentrated ammonia liquor; while others believe the best plan is to recover half the ammonia at the gas-works as a solution containing 40 p.ct. of sulphate. The author points out that local conditions will be the deciding factor in the choice of method, but states his preference for the 40 p.ct. sulphate solution where the circumstances are favourable—*i.e.*, where the centrally situated chemical works treating the ammonium sulphate solution are not more than forty miles distant. Operation of the process, it is true, throws extra work on the oxide purifiers, which may be called upon to remove an additional 10 p.ct. of hydrogen sulphide; but this does not constitute a serious disadvantage.

As our readers are aware, Mr. Parrish is an authority on the subject; and this fact lends added importance to his comparison between the common system of converting gas liquor into ammonium sulphate—by the use of sulphuric acid—and the anhydrite method in which calcium sulphate is the source of the SO_3 ion. The complexity of the latter process and the importance of large-scale operation (in the author's opinion a plant to deal with less than 30 to 40 tons of ammonium sulphate per day would not be warranted) are not generally realized. Whether or not the method will prove an economic success depends largely on the geographical position of the ammonia works in relation to the anhydrite mines. For example, gypsum which costs 12s. 6d. a ton at the mines costs double this amount delivered in London.

It is obvious that Mr. Parrish is not enamoured of the direct process of ammonia recovery, of which Mr. L. H. Sensicle is such an ardent advocate. Indeed, the author goes so far as to say that there is no such thing—"it is more imaginary than real." The so-called direct process, moreover, results in ammonium chloride being carried to the saturator, where it is dissociated; the hydrochloric acid thereby formed setting-up corrosion not only in this apparatus, but in the mains leading from it. Nor is the author at all favourably impressed with the semi-direct system, in which, he says, the bath is diluted by the water vapour resulting from the condensation of the steam from the steam-ammonia stream. This occasions loss by the production of redundant mother liquor, and the sulphate produced is in the form of a powder of an indifferent colour.

The excellent contribution of Mr. Parrish—a lengthy extract of which will be found in later columns of our issue to-day—once again points to the need for exploring every avenue which may lead even to a partial solution of the ammonia problem as it affects the gas industry at the present time. The only thing to be regretted is that the author did not touch upon the question of effluent disposal, for this is really inseparable from any consideration of ammonia recovery.

Savings to be Effected by Amalgamation.

Consideration was given to the position of the gas industry of this country by Prof. R. B. Leckie, of Purdue University, in a paper submitted to the Indiana Gas Association. He discussed the thermal basis of charge for gas, and naturally drew upon the valuable experience of Great Britain in this matter. Admitting that our gas industry, as is the case in America, always has been well managed, he pointed out that advantage has not been taken to the extent that it has in the United States, of the savings to be effected by company amalgamation, which makes possible centralized production and the consequent linking-up of communities by high-pressure transmission mains.

The Industry's Claims Supported.

When, in recent numbers of the "JOURNAL," we voiced the general feeling of dissatisfaction which pervades the gas industry at the apparent lack of consideration accorded it by the Government, it was with the fervent hope that our readers would not think that we had abandoned our Constitutionalist, but somewhat non-party, political complexion for a violently reactionary attitude. Therefore it is with pleasure that we find the views we have expressed strongly supported by Col. A. England, C.M.G., D.S.O., the Member for Heywood and Radcliffe, who is himself a Constitutionalist. In a letter to "The Times" of last Thursday he remarks that rationalization and freer development are not uncommonly regarded as essential to commercial prosperity, and that there is in the country undoubtedly a feeling that the gas industry should be allowed some relaxation from its very restrictive conditions—"greater freedom in the national interest." After briefly referring to the restrictions from which the gas industry seeks to be relieved, Col. England expresses the view that the claims ought to be capable of adjustment in the interests of everybody, and that these claims will very soon be regarded as an issue of first-rate importance. The letter opens by stating that most Members of Parliament hear early echoes of the forming sentiments of their constituents, and closes with the opinion that the Government of to-day will be wise to realize the strength of public opinion.

A Farthing a Unit.

We can imagine that the organizers of the World Power Fuel Conference, and Mr. R. P. Sloan, C.B.E., were not a little surprised at the widespread publicity accorded last week by a large section of the Daily Press to the paper which Mr. Sloan had prepared for Section J of the Conference. In some cases florid headlines and a stirring introduction to extended extracts from the paper might well have led the public to believe that they would shortly be receiving a supply of electricity at one-farthing a unit; and indeed, we ourselves, who have by now learnt to weather such shocks, were led to peruse Mr. Sloan's paper a little earlier than would otherwise have been the case. There we find no mention of the farthing per unit, and, in strange contrast to the fervour of the Press, a delightfully modest account of what has hitherto been achieved, in the combination of coal distillation and electricity generation, by that excellent undertaking, the Newcastle Electric Supply Company.

The Products Market.

Mr. Sloan points out that as regards "the possibility of using coal distillation in conjunction with electricity generation, considerations may arise over and above the question of economy, such as the desirability of producing oil and other products to meet an increased demand. Under present conditions it is not likely that any large direct economies may result; but conditions may change, and consequently the careful study and extensive experiments that are being made in this direction may be of the greatest use in the future." Further, the author acknowledges that commercial success of a process must depend on finding the best market for the sale of the bye-products of distillation, as the power station buys only the gas and coke, and pays for them at their heat value. "Under present conditions and at present prices," says Mr. Sloan, "no important commercial economies have so far been obtained"—in support of which statement he quotes the figures which were seized upon by the Daily Press with such avidity; and in a footnote he refers to some of the difficulties which had to be overcome by the Newcastle Company before the *present measure of success* was attained.

Sensationalism.

Is it not a pity that some sections of the Daily Press seem impelled to clutch at anything sensational, even though the subject be beyond any but the fuel technologist? In this instance much is likely to emerge in discussion. Has it been realized, for example, that whereas coal is probably obtainable at 6d. per ton less than the figure quoted by Mr. Sloan, the current prices of the residuals might yield nearly 2s. per ton carbonized less than his suggested return? And it would surprise us to receive confirmation that the quality of certain of the low-temperature products is up to the usual standard demanded. The author, as quoted above, speaks of considering the desirability of manufacturing these products to meet an increased demand; but of many of them there is already a world over-production, and therefore whatever additional quantities are put on the market will cause a reduction in prices. It is not our desire to criticize Mr. Sloan's paper in undue season; we seek, rather, to emphasize the undesirability of sensational comment.

New Charge Systems at Rochdale and Stretford.

As announced in last week's "JOURNAL"—*ante* p. 606—the Rochdale Gas Department have adopted an optional two-part system of charging for gas which should greatly encourage its use for all purposes, and particularly for heating and water heating. Domestic consumers can now have their gas either at the ordinary rate of 3s. 7d. net per 1000 c.ft., or, under the new two-part method, at 2s. net per 1000 c.ft. *plus* a fixed charge of 10s. per quarter. With the latter system, consumers must sign an agreement to remain on the system for twelve months, and the arrangement is subject to three months' notice thereafter. The charge of 2s. per 1000 c.ft. is equivalent to 5·054d. per therm; and gas at this price can face any type of competition. The Stretford and District Gas Board have evolved a two-part charge for gas used for manufacturing purposes, which relieves the manufacturer from the possibility of bearing any charges other than those incidental to the particular service and supply given. There is an annual charge based on the 12-hour maximum demand. For the first 10 therms this is £5, for the next 40 therms £4 10s., for the next 100 therms £4, and so on. In addition to this there is a commodity charge. For the first 500 therms per month this amounts to 3d. per therm, for the next 4500 therms 2¾d., and so on till, for all consumption above 50,000 therms per month, the charge is 2d. a therm. The prices are subject to a discount of ½d. per therm. We look forward with interest to the results of the enterprise of Rochdale and Stretford.

The "Gas Salesman."

The September "Salesman," issued with this number of the "JOURNAL," marks for us the close of the summer season; and from now to the end of March next we publish the Supplement twice monthly. The current number contains several articles worthy of special comment. One is a strong plea, by Mr. R. S. Ross, that all units of the gas industry should fight for the lighting load, casting off lethargy and eradicating the illusionary idea that the fight will be a losing one. Mr. Ross is of opinion that neither shop lighting nor house lighting is difficult to obtain if a gas undertaking will adopt a maintenance system. Then there is published a most useful paper on gas fitting, by Mr. L. Sturdy, of the Birmingham Gas Department, before the Midlands Circle. A further illustrated contribution shows that the Gas Light and Coke Company have recently installed no fewer than 79 gas radiators at the Palladium Theatre.

PERSONAL.

Viscount LEVERHULME has been elected President of the Incorporated Sales Managers' Association; and Mr. F. W. GOODENOUGH, C.B.E., has been re-elected Chairman for the third year in succession, in view of his appointment as Chairman of the Advisory Committee on Education in connection with the Board of Education special inquiry on training for salesmanship.

RETIREMENT OF MR. WALTER T. DUNN.

Thirty-Two Years' Devoted Service.

Walter T. Dunn, M.I.Mech.E.

At the last meeting of the Council of The Institution of Gas Engineers, the President reported that he had received a letter from Mr. Walter T. Dunn resigning his position as Secretary of the Institution. The resignation was accepted; the Council placing on record their appreciation of his long and faithful service, and expressing the hope that his health will improve so that he may enjoy many years of well-earned rest.

Mr. Dunn was appointed in 1896 to succeed Mr. F. G. Burfield as Secretary of the Incorporated Gas Institute; and when amalgamation of the latter with the old Institution of Gas Engineers took place in 1902, Mr. Dunn was selected as Secretary of the new corporation, and carried out the duties of that office continuously from the Statutory Meeting until he left for his holiday in August. Thus he has completed thirty-two years of hard and patient work; and this is a span upon which any man may look back with pride, and feel that he has earned some relief from the burden. In some corporate bodies, the secretaryship is, if not a sinecure, a post of which the duties may largely be delegated to others; but Mr. Dunn has aimed always to give his personal attention even to the smallest detail, and to make himself responsible for the smooth and efficient working of an Institution whose members are very widely scattered over the country. And not one but will testify to Mr. Dunn's unabated energy, optimism in the cause of gas, and eagerness to turn every occasion to account in advancing the claims of gas. Undoubtedly his assiduity has done much to bring to the Institution the recognition which is its due; and the part he has played in the preparation of the Charter Petition will always be remembered with gratitude.

Mr. Dunn's circle of friends and well-wishers extend far beyond the gas industry of this country, for he has on many occasions officially represented the Institution at the meetings of kindred bodies at home and abroad. He is also a member of the Institution of Mechanical Engineers and of the Chartered Institute of Secretaries. At the last annual meeting of the latter he was re-elected a Member of Council for a further period of three years. Of The Institution of Gas Engineers, he is an Associate, so that the new régime will not sever for him a long and dearly-loved connection. The gratitude of the industry and the best wishes of all follow him into retirement.

FORTHCOMING ENGAGEMENTS.

[Secretaries of Gas and Kindred Organizations are asked to assist in making this diary of events as complete and useful as possible by sending the earliest intimation of all meetings.]

Sept. 24-Oct. 6.—WORLD POWER CONFERENCE, FUEL CONFERENCE.—Imperial Institute.

Oct. 3.—SOCIETY OF BRITISH GAS INDUSTRIES.—Council meeting in the afternoon.

Oct. 5.—NORTH OF ENGLAND GAS MANAGERS' ASSOCIATION.—Meeting. Presidential address of Mr. D. Currie.

Oct. 6.—MANCHESTER AND DISTRICT JUNIOR GAS ASSOCIATION.—Annual meeting in the Town Hall, Rochdale. Presiquential address by Mr. H. J. Hailstone, A.M.I.Chem.E. Inspection of the Rochdale Gas-Works.

Oct. 6.—SCOTTISH JUNIOR GAS ASSOCIATION (EASTERN DISTRICT).—Meeting in Edinburgh. Address by Mr. F. J. Dent, B.Sc.

Oct. 11.—MIDLAND ASSOCIATION OF GAS ENGINEERS AND MANAGERS.—Autumn general meeting at the Imperial Hotel, Birmingham, 2.30 p.m. Discussion on maintenance to be opened by Mr. R. J. Rogers, of Birmingham. Discussion on "Gas Undertakings' Insurances," to be introduced by Mr. A. S. Foster, of Stourport.

Oct. 11.—MIDLAND JUNIOR GAS ASSOCIATION.—Meeting in the Council House, Birmingham. Presidential address of Mr. F. Caudwell.

Oct. 16.—SOUTHERN ASSOCIATION OF GAS ENGINEERS AND MANAGERS (EASTERN DISTRICT).—Meeting at 28, Grosvenor Gardens, S.W. 1, at 2.30.

Oct. 17.—MANCHESTER DISTRICT INSTITUTION OF GAS ENGINEERS.—Meeting in Manchester. Visit to the works of Messrs. R. & J. Dempster, Ltd. Paper by Mr. William Buckley on "The Maintenance Costs of Vertical Retorts."

Oct. 18.—EASTERN COUNTIES GAS MANAGERS' ASSOCIATION.—Autumn meeting in London.

Oct. 22-24.—BRITISH COMMERCIAL GAS ASSOCIATION.—Annual Conference at York.

Nov. 22.—SOCIETY OF BRITISH GAS INDUSTRIES.—Autumn general meeting. Hotel Cecil.

THE INSTITUTION OF GAS ENGINEERS.

All meetings take place in the Council Room at 28, Grosvenor Gardens, unless otherwise stated.

Oct. 9.—Gas Education Committee.

Oct. 10.—Finance and Executive Committees in the morning; Corrosion of Pipes Committee in the afternoon.

ON THE ELECTRICAL SIDE.

In Early Days.

One of a series of lectures given for the benefit of the Brighton and Hove Branches of the League of Nations Union was by Mr. H. G. Massingham, one of the early pioneers of the electrical industry in this country, who claims to have been responsible for the lighting of the first town in the United Kingdom to be permanently and successfully illuminated by electricity. This was not such a great number of years ago; but he has lived to witness remarkable developments. Within half-a-century, electricity has risen from the smallest beginnings to its present position of importance; and what has the future in store? To this question Mr. Massingham endeavoured to supply an answer, in addition to indicating the broad lines of development in the past. His allusions to what has gone and what he thinks is to come were equally interesting; and for the benefit of those who would like to study the lecture, it has been reprinted in booklet form, at the price of 6d. net, by Messrs. Hutchinson & Co., Ltd., 34, Paternoster Row, London, E.C. 4. It is the ancient borough of Taunton which has the reputation of being the first town in England to have been permanently and successfully illuminated by electricity; this town being followed by Bath and Exeter. It is Taunton, too, which enjoyed the distinction of being the first town in the United Kingdom to hold an electrical exhibition.

Mr. Massingham saw electricity coming in "at a time when gas was very poor, and our gas industry in a very apathetic condition; gas being used only as an illuminant by means of very crude burners that are now discarded. The bright and cheerful gas fire, and the useful gas cooker, had not then been evolved"—in their present form, they had not—"but the threatened competition of electricity put new life into the gas industry, and caused gas engineers to bring out various forms of greatly improved burners, and to turn their attention to the utilization of gas for other purposes than that of lighting only, to the great advantage of the public and of the gas industry." From this one would infer that electricity, as we now know it, experienced a calm and uneventful youth; but actually this does not appear to have been the case, for Mr. Massingham refers to the strenuous times when he "was trying to prove that the lighting of a town by electricity was not a mad dream, as some supposed, but could be made a practical reality." Later on we find electricity suffering in the same way as gas has done. Contribution by municipal committees to the relief of the rates, instead of applying profits to a reduction in the charges for the supply of the commodity, and so benefiting the consumers out of whose pockets the money has come, has been a sore point with Mr. Massingham, as it has with so many students of gas administration. He would have local authorities vying with each other to supply electricity at the lowest possible cost, which is doubtless the most advantageous, as it is the fairest, course to adopt for the electrical industry, and for the gas industry. He would like to see imposed a minimum fixed rate according to the size of the house, *plus* a nominal charge of about 1d. per unit for all current consumed beyond the fixed amount charged for, so as to encourage an all-day domestic demand.

In early days Mr. Massingham outlined the probable future developments of electricity; and these suggestions he sees nearer fulfilment now than they were then. One of these suggestions was that super-electricity stations would be constructed at or near the pit's mouth; the ordinary stations being used only as transformer and distributing stations. Another suggestion was that, as knowledge of transmission still further improved, all power would eventually be obtained for the production of electrical energy from the various waterfalls of the world, and that the United Kingdom would probably secure its principal supply from the great waterfalls of South Africa—the power being converted into electrical energy on the spot, and transmitted through the air to suitable receivers in this country, without the aid of wires or cables to act as conductors. Is this, after all, to be the solution of the much-debated problem of overhead transmission?

Electric Heat in the Dairy.

Persons who are threatened with an increase in the price of the household milk supplies may read with some surprise a statement in the "Electrical Review" to the effect that "at the present time British farming is passing through a period of readjustment. Due to a number of causes, arable land is decreasing in acreage, and pasture land is taking its place. Consequently, the head of stock is greater to-day in England than it has ever been, and the production of milk is steadily increasing." Why, then, one wonders, is milk to be dearer. However, it is not Mr. H. A. Carney's object, in writing in our contemporary, to draw attention to the laws of supply and demand as applicable to milk, but to make reference to the valuable opening which exists for electricity in the dairy. He quotes an estimate of Dr. Stenhouse Williams (of the National Institute of Research in Dairying) that from 1 to 2 p.ct. of the milk produced in Britain is lost annually through going sour before it reaches the distributors. This sourness is the outcome of dirty conditions; and hot water and steam are the essentials without which ideal conditions are impossible on the farm or in the town milk shop. Well, there are various methods by which hot water can be supplied; and there is no reason why electricity should regard as its own the task of saving this enormous amount of wasted milk. The consumer may even wish that it will not be saved at all, lest its addition to the quantity already available should lead to another increase in the price per gallon.

Prepayment Electricity Consumers.

The "sweet simplicity" of the flat-rate system of charging for gas makes it easily applicable to the requirements of the prepayment consumer; whereas if it is desired to offer the more complicated systems in vogue in the electrical industry to their consumers, some special methods are called for. In this country the tariff for a supply of electricity is usually one of the following: Two distinct rates (lighting and heating) involving two meters; a form of fixed and unit charge—such as the "Norwich" system, or a charge on rateable value *plus* a price per unit; a sliding scale which varies with amount consumed; or a two-rate system based upon the time of day during which the load is taken.

Mr. B. M. Smith, writing in the "Electrical Review," remarks that all these systems have their own particular merits; but they fail to get at the man who will not have a quarterly bill. If, therefore, the prepayment consumer is to be adequately catered for, means must be introduced of collecting fixed and unit charges through a slot meter, with the one insertion to cover both charges. Three ways in which this may be done are indicated, but only one is considered suitable.

This is to arrange the meter so that a proportion of each shilling inserted is taken to cover the fixed charge—units to the value of the remainder being delivered to the consumer. In other words, the meter collects both charges, but differentiates between the two; the dial only registering units consumed. Such a meter is described, and will no doubt be very useful when the electrical industry decides to go out after the slot meter consumer. The moral pointed is that electrical engineers, in formulating schemes and tariffs, should discuss the subject with representative meter manufacturers. In view of the consideration that is being given in the gas industry to the question of methods of charge, this contribution to the subject may be kept in mind.

More About Overhead Transmission.

Through the medium of the Daily Press, there was published far and wide last week an announcement to the effect that the first step in carrying out in the Central Scotland area the Government scheme for the provision of cheap electricity throughout the country has been taken near Easterhouse, about 8 miles from Glasgow, when three of the steel towers which will carry the overhead power lines were completed or partially erected. It was added that, to the end of March, 1934, the total capital expenditure on the scheme over the whole country was estimated at almost £6,000,000. It seems that in the section on which work has been begun, extending over a distance of approximately 20 miles from Clydesmill, Cambuslang, to Bonnybridge, 150 towers will be erected; the average span between each being about 300 yards. It is anticipated that this section (which will link-up the systems of the Clyde Valley and Scottish Central Electric Power Companies) will be ready to be operated by the end of April. The towers will range in height, according to the nature of the ground over which the line is being led, from 60 ft. to almost 300 ft.; towers of the latter height carrying a span across the River Tay on the line to Dundee. A local press man states that, except where a tower stands out prominently on the skyline at the top of a rise in the ground, it is not easy to detect the presence of the structures from a distance of a few hundred yards; and the "silvery lattice-work of which they are built-up is in pleasant contrast to the gaunt blackness of the ordinary telegraph poles." This is none too comforting, for it would be difficult to find anything which would compare unfavourably with the ordinary telegraph pole.

It is, however, the reference in the opening sentence of the above paragraph to this step in carrying out the "Government scheme for the provision of cheap electricity throughout the country" which leads to mention of the matter here. The appearance over the land of numbers of these structures—resembling (we are told by one picturesque writer) a single-file procession of baby Eiffel towers, protected to several feet from the ground by barbed wire—is unpromising enough; but even more serious may this promise of cheap electricity prove to be. We have sometimes wondered what will happen should all the fine promises, so lightly made, remain unfulfilled; and we are not reassured by the weighty warning of the "Electrical Review," which notes with regret "that the misleading announcements of 'cheap electricity' are again appearing—emanating apparently from a common source." "The Times," it is stated, describes the Scottish scheme as "reducing the cost of power for all purposes to less than a penny per unit;" and the "Daily Chronicle" even more definitely says "including domestic lighting and heating." The writer goes on to point out that, while the average cost of electrical energy for all purposes may in time be brought down to a penny, the public does not understand that the operations of the Board will not affect the largest item in the selling price of electricity for domestic purposes.

REPORT OF THE NATIONAL FUEL AND POWER COMMITTEE.

The National Fuel and Power Committee appointed by the Board of Trade last September, to "consider and advise upon questions connected with the economic use of fuels and their conversion into various forms of energy, having regard to national and industrial requirements and in the light of technical developments," have presented a report. Here we give the Committee's recommendations, and publish *in extenso* that section of the report dealing with carbonization.

The members of the Committee who sign the report are as follows:

Chairman—Lord Melchett.

Mr. J. BAKER, M.P., the Iron and Steel Trades Federation; one of the Labour Members on the Balfour Committee.

Mr. MARK BRAND, a Director of William Baird & Co., Ltd., and of Sanquhar and Kirktunnel Collieries, Ltd.

Sir JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., Technical Adviser, Anglo-Persian Oil Company; Member of the Council of Scientific and Industrial Research.

Sir ARTHUR DUCKHAM, K.C.B., Specialist in furnace work, carbonization of coal, and engineering connected with chemical developments.

Sir WILLIAM HART, O.B.E., Town Clerk, Sheffield.

Mr. FRANK HODGES, Secretary of the International Miners' Federation; formerly General Secretary of the Miners' Federation of Great Britain (*Deputy Chairman*).

Prof. F. A. LINDEMANN, F.R.S., Professor of Experimental Philosophy at Oxford; Director of the Physical Laboratory of the R.A.F., Farnborough, during the war.

Mr. M. MANNABERG, Director of the United Steel Companies, Ltd.; Bolckow, Vaughan, & Co., Ltd.; the Frodingham Iron and Steel Company, Ltd.; the Appleby Iron Company, Ltd.; and Chairman of the Fuel Economy Committee of the National Federation of Iron and Steel Manufacturers.

Mr. C. H. MERZ, M.I.E.E., F.R.G.S., Consulting Engineer; Senior Partner of Merz & McLellan, Westminster; Specialist in electric traction and power supply problems and fuel economy.

Sir ALEXANDER WALKER, K.B.E., a Director of John Walker & Sons, Ltd., Distillers.

Sir DAVID MILNE-WATSON, D.L., Governor of the Gas Light and Coke Company.

The Secretary of the Committee is Mr. W. Palmer, and the Assistant Secretary Mr. R. J. Moffatt.

CARBONIZATION.

General.

The carbonization of coal at what is generally known as low temperature has attracted a good deal of attention during recent years; and much important work has been done, both in this country and abroad. The Fuel Research Board have devoted much time to the subject. On behalf of the Government they have offered to test any low-temperature carbonization plant which is claimed to have arrived at the unit commercial stage; the proprietors supplying the coal and actually running the plant during the test. This offer has been open for nearly three years, and several plants have been tested under it. In addition the Board itself have developed a process of low-temperature carbonization, and it has already been announced that the Government have made arrangements with the Gas Light and Coke Company whereby this process is to receive a trial on a commercial scale.

Most of the work on these processes has been definitely experimental in character, as was to be expected in the evolution of a new industry; but there appear to be several processes now entering the commercial stage. Still more time, however, will be required to ascertain to what extent, if any, commercial success has been attained.

A good deal of work has yet to be done before the limitations of the commercial applicability of these processes are fully determined; and we shall watch the present developments with interest. The national advantages to be obtained from any scheme which offers a possibility of adapting our national fuel to purposes for which at present we are dependent on imported fuels are so great that the fullest and most patient investigation is imperative.

There are, however, two important and firmly established coal carbonizing industries—the gas industry and the coke oven industry—and a great deal of our attention has been devoted to them. The general character of the carbonization process in gas-works and coke ovens is very similar, but the differing objects of the two industries have caused them in practice to develop into two almost entirely separate industries. The aim of the gas industry has been primarily to produce gas for town supply, and secondarily to produce a coke for industrial and domestic purposes. The industry, with improved practice, has produced increasing quantities of other bye-products. The coke oven industry, on the other hand, was started for the different purpose of supplying a hard coke for the iron and steel industry. It is well known that for many years all other possible products from the coal were neglected, but in recent years there has been a great change in this respect, and the coke oven industry has paid more and more attention to its bye-products, such as tar, ammonia, and gas. But it remains true that the coke oven industry is still mainly concerned with the production of metallurgical coke. We are doubtful if so pronounced a separation of these two closely allied industries has been entirely advantageous, and are of opinion, as explained later, that it would be desirable for them in many cases to have closer co-operation.

The Gas Industry.

Research is being carried on in connection with the gas industry, and improved practice has resulted from the adoption of the results of those researches. This industry is one that has

adapted itself to modern conditions, and in consequence has expanded rapidly and is continuing to expand. It may be that for internal illumination gas lighting is giving place to some extent to electric lighting, but for heating, both in households and in factories, gas is rapidly gaining fresh adherents. Some idea of the increase in the gas industry may be gained from the following figures:

Production of Gas by Authorized Gas Undertakings.

Year.	Million Cubic Feet.
1884	73,718
1904	155,580
1923	259,849
1924	275,225
1925	283,818
1926	296,082
1927	297,697

We have no doubt that the gas industry as a whole is now, within the limits within which it is confined by Statute, a progressive and efficient industry. The thermal efficiency of the process of conversion of coal to gas, coke, and tar is high, and is being increased; and the efficiency of the appliances for using gas is also high. A considerable part of the credit for the development of coke boilers for domestic heating and hot water supply—one of the features of the modern house—is due to the readiness with which the gas companies have produced and supplied fuel. The practice of using for the production of water gas any coke for which there is no market, has overcome the difficulties of the seasonal nature of the demand for coke.

THE COKE OVEN INDUSTRY.

One of the representatives of the Coke Oven Managers' Association criticized severely the coke oven industry in this country. Whereas in 1914 British coke ovens were approximately equal in efficiency to the Continental ovens, except that the number of ovens per battery was generally smaller, the position was, in this witness's view, that in this country there had, except in a few cases, been no progress since that date, while the Continental practice had advanced. In the United States of America larger and narrower ovens of the regenerative type, lined with high-grade silica brick, have been in general use for many years. Since the war the internal prosperity of the United States has provided funds for the renovation of plant and the installation of the most complete mechanical devices. Moreover, the concentration in the United States of the iron and steel plants has favoured the construction there of coke oven plants in large units, to which the coal is brought, rather than in units which, irrespective of the most efficient size, are erected at the pit-head.

As regards the present Continental practice, it was suggested that the majority of coke ovens had been rebuilt on modern lines, since the war, either as a reconstruction measure or at a low real cost at a time of depreciated currencies. The Continental practice was, therefore, also in advance of British practice.

The Coke Oven Managers' Association placed before us their views of the improvements that they considered necessary in the British coke oven industry if it was to be able to offer cheap and reliable coke to the iron and steel trades. Their suggestions were these:

(1) The old type of inefficient and uneconomical oven, constructed in small batteries, must go; and for every four, five, or six of such units, one large central plant of large-capacity, narrow, silica brick ovens with modern subsidiary plant must be erected.
(2) In many cases amalgamations of coking interests are essential.
(3) The sale of surplus gas must be ensured, either as gas or for producing electrical power. The gas undertakings should assist in so far as its sale as gas is concerned, and the Electricity Commissioners in so far as electric power supply is concerned.
(4) The blending of coal should be encouraged.
(5) The cleaning of coal in all its aspects should receive close attention and should be adopted wherever possible.

It was obviously necessary for us in these circumstances to pursue further the matters brought to our notice by the Coke Oven Managers' Association; and accordingly we furnished a copy of their evidence to the Coke Oven and Bye-Product Plant Owners' Association, and invited them to give us their views on the subject. A representative of that Association appeared before us. He was much less certain of the advantages to be obtained by a general reconstruction of the British coke oven plant. He agreed that the present plant was, in many cases, not what the owners would erect if they were building now; but it was, he suggested, serviceable, and produced a coke that was generally acceptable to the iron and steel industries. The plant was, too, erected at a time when costs were much lower than now.

The Coke Oven Owners' Association were not prepared to accept in detail the calculation of the reduction in costs claimed by the Coke Oven Managers' Association as a consequence of the erection of new centralized plants, and the Owners' Association concluded generally that there was not a sufficient case for a wholesale condemnation of the existing methods. They pointed out that, since the post-war boom, their industry had suffered by reason of the depression in the iron and steel industry and the smaller demand for metallurgical coke. The coke oven industry was not, therefore, prosperous enough to expect to be able to earn profits on new and expensive plant, and at the same time set aside funds for writing off the value of the old plant.

We recognize the real financial difficulties of the coke oven industry, but at the same time we are left with the impression that the coke oven plant of the country is in general far below the standard of efficiency that our needs require, and we recommend that the owners should, in many cases, consider plans for re-organizing their oven plants as soon as possible into installations serving a number of collieries and equipped with a modern type of oven. The question of the most suitable location for the plant also requires consideration.

One point on which the coke oven managers and owners were agreed, however, was that it was very important that the coke oven industry should obtain a profitable outlet for its surplus gas. A modern coke oven has a large surplus of gas of high calorific value, especially when it uses a cheaper fuel such as producer gas or blast furnace gas for firing the ovens. And the maintenance of the plant on economical lines is dependent on the disposal of this gas for purposes apart from the plant.

There is no doubt that it is of great importance to the economy of coke oven practice that this gas should be used to the fullest extent, and that it is not in many cases easy to arrange this. In the United States of America and in the Ruhr, where the iron and steel works are concentrated into large units and the coal is generally carbonized near the works, the steel works themselves are able to take a large quantity of gas for heating and power production. These works are also of necessity situated near large centres of population, and much of the surplus gas can be supplied as town gas. In Great Britain the iron and steel works are not concentrated to the same degree, and the coke ovens are in general situated at the pit-head. As about 30 cwt. of coal are required to produce a ton of coke, there is a saving in freight by carbonizing at the pit-head and transporting the coke instead of the coal.

One of the directions in which the coke oven industry thinks it could obtain great assistance is by being able to dispose of its surplus gas for town use. It is not suggested that the gas is wasted at present; indeed, an investigation in 1921 showed that comparatively little was not then used for one purpose or another. But modern practice renders coke oven plant more and more efficient, and so releases an ever-increasing quantity of gas for sale. The industry claim that the gas is well adapted for town use, and that in the majority of cases this is the most profitable outlet for it. It is common knowledge that a number of agreements have been reached in the past few years for the supply of gas by coke oven owners to neighbouring gas supply authorities, but the coke oven industry think that this movement should extend more rapidly, and have suggested that a gas supply authority should not be permitted to obtain capital for new plant when coke oven gas is available in the district on reasonable conditions. Many considerations have been put before us on both sides. The gas industry have pointed out that it is essential to the maintenance and development of their business that the public should have confidence that the gas supply will be uninterrupted and regular in quality. It is difficult or impossible for the coke oven owner to guarantee this. He is essentially a coke producer; and if the demand for coke falls off, he cannot usually carbonize coal for the sake of gas alone. Also there may be difficulties about storing coal or coke for such a period (say) as the coal stoppage of 1926; and labour troubles have been more frequent among coke oven workers than among gas-workers. The gas supplier must, therefore, retain spare plant for use when the coke oven gas supply fails. As against these views, the coke oven owner suggests that he is quite able to guarantee a supply of gas of suitable quality; that he can store coal against an emergency equally as well, if not better than, a gas-works; and that reference to the records of labour stoppages shows that during such periods supplies of coke oven gas were continuous, though perhaps on a reduced scale. It will be observed from the table in the next paragraph that the supply of coke oven gas to statutory gas undertakings was greatly reduced during the coal stoppage of 1926.

The fact remains, however, that in a number of cases coke oven owners and gas supply authorities have come to an arrangement of this kind. The table below shows the quantities of coke oven gas bought by statutory gas undertakings in recent years; and we expect to see an increase in those figures in the near future.

We are glad to hear also that, since we began our investigation of the subject, the National Gas Council and the Coke Oven Owners have recognized that this question, which is of great importance to both of them, should be explored by the representative bodies. We are of opinion that the conversations which, we understand, are now proceeding between them will result in a better understanding of their respective positions, and we have real hope of greater co-operation resulting in the future.

Proposals are often made for the use of coke oven gas for town purposes which involve transmission of the gas for considerable distances by pipelines. Gas has been for some years

Coke Oven Gas Bought and Distributed by Statutory Gas Undertakings.

Year.	Number of Purchasing Undertakings.	Quantity Bought. (Million C.Ft.)
1921	14	1325
1922	16	3636
1923	16	4268
1924	18	4471
1925	21	4798
1926	22	2321
1927	24	5340

carried from the Ruhr district in Germany some 40 miles, and there are now proposals for a system of large gas mains extending over 150 miles and connecting many of the more distant urban centres with the coal districts. In one case at least, the mains have been laid, and a service of gas is now being given. The desirability of such a system in Germany depends probably on a number of considerations. For example, many German towns obtain their gas coal from distant sources and even from foreign countries. The same considerations do not apply with anything like the same force to many of the large centres of population in Great Britain. Taking the case of London, for example, it has been pointed out that there is a heavy demand in London for coke for domestic purposes, and if the coal were carbonized at the pit, it would still be necessary to bring coke to London. Further, good gas coal is available in Durham near the seaboard, and can be brought to the Thames at low rates by water; the cost of transport of this coal being less than any estimate we have seen of the cost of pumping gas for such distances. This second consideration does not apply with the same force to many other large centres of population in this country; and the possibility of developing a system of gas mains in industrial areas near coalfields is a matter which, in our view, requires detailed investigation.

In recent years also developments of this kind have been taking place in Belgium and Northern France; and it seems at least likely that, in some of the industrial districts on the Continent that bear the closest resemblance to our own industrial districts, development is in the direction of the construction of a network of gas mains bearing some resemblance to the projected national electricity supply network in this country, the network being fed by gas produced mainly at coke ovens.

It has become clear to us, however, that it is impossible on the evidence before us to say whether a gas network of this kind would be useful in this country as a whole or in particular districts. The industrial interests involved are varied, and consist of a large number of independent units; and we see no likelihood of a survey of the question of the necessary width being made except by the Government. Such survey should in our judgment also consider the disposal of the coke, the location of coke oven plants with respect to iron and steel works, and the existing and potential consumption of coke, whether for the iron and steel industry or for domestic purposes. We think the time has come when such a survey is essential to the future development of some of our fuel industries, and we recommend, therefore, that it should be undertaken by the Government. We suggest that the investigation might in the first place be confined to an area such as that lying between the Humber and Liverpool and between Leeds and Birmingham. This is a highly industrialized area, and includes many coke ovens and gas plants, important industrial gas users, and a large urban population.

We recognize, of course, that apart from technical questions, a gas supply network of this kind involves many difficult administrative problems, but we think that at present it would be desirable to confine the investigation to the technical and economic aspects of the question. If it is found that the advantages to be obtained are sufficient, we have little doubt that the administrative difficulties, however serious they may be, will be overcome.

We have suggested an investigation in a limited area, but, of course, we cannot lay down in advance any precise limits for the area; only the technical investigation can disclose what the limits can properly be. Nor can we with any certainty forecast what personnel would be required for the investigation, or what its cost would be. But we think that a small Committee of qualified persons, working in consultation with ourselves and provided with the necessary paid staff to make the detailed investigations, should in the course of a year produce preliminary results of such value as to enable a decision to be made as to whether it would be worth while to proceed with the investigation; and that the cost of this preliminary work should not exceed £10,000.

The proposed Committee might, we suggest, be composed of two representatives of the gas industry, one representative of the coke-oven industry, one representative of the iron and steel industry, one representative of the colliery industry, and an independent chairman having technical and commercial experience. In an investigation of this kind the economic and scientific aspects of the problem cannot be entirely separated, and as the Department of Scientific and Industrial Research are already in possession of much information on the scientific side of the question, it is obviously desirable that that Department should take a part in the investigation, through membership of the proposed Committee, or otherwise.

The investigation would ascertain the present consumption of gas in the area; the amount of coke oven gas available for distribution and its possible uses; the probable developments of gas supply and demand, both present and potential; and the cost of installing gas mains to inter-connect the various gas producers and distributors. We would again point out that it would be necessary for the proposed Committee to give close attention to the coke position. They should ascertain whether there might be a surplus of coke, metallurgical or domestic, which would adversely affect the coke market, and so annul the benefits that might accrue from the adoption of such a scheme of gas distribution.

The use of coke oven gas to generate electricity for the national supply system has been advocated as an alternative to its use as town gas in appropriate cases where the coke ovens are situated far from any town. The view put before us from the electrical engineer's side of the question was that the efficiency of generation from coal in large modern central stations has been increasing rapidly, and is now so high, that a station designed to supply the grid would have to obtain gas at a very low rate in order to compete. The value of the gas for this purpose would be approximately the same as that of coal of equal calorific value; and the gas would not, therefore, obtain such a high price as it would if sold as town gas. But a good deal of coke oven gas is being used for generating electricity for electric supply authorities; and it may well be that in particular cases it will still be possible to find that this can usefully be done. The investigation referred to above would also assist in giving us a more complete view of this subject by showing to what extent there is available gas which is not now put to appropriate use.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS.

The main conclusions and recommendations in the body of the report are here briefly summarized:

(1) We should like an early opportunity of examining the information regarding fuel consumption in industry obtained from the Census of Production returns; and if this voluntary question has not been answered in any large number of cases, we should like to consider, before another Census is undertaken, whether we should not recommend the Government to obtain compulsory powers for requiring users to give details of the amount of fuel used and the purposes to which it is put.

(2) Those responsible for the conduct of the coke oven industry would be well advised to institute, by the formation of a National Research Association embracing the existing local Associations, organized research into coking problems.

(3) Industrial leaders in the fuel-producing and fuel-consuming industries should consider the need for co-operation with the Universities by indicating the responsible positions that are open on the executive side of their businesses for men trained in fuel technology. The Board of Education should also consider what might be done in the institutions supervised by them to contribute to the training of men with the desired qualifications.

(4) The iron and steel industry should give greater support to its Fuel Economy Committee, both by providing it with sufficient funds, and by actively co-operating in its work through placing at its disposal all necessary information of new or improved practice and referring to it in all cases of difficulty.

(5) All large coal-consuming industries should consider the desirability of adopting on a much larger scale than at present the practice of an exchange of experiences in fuel technology, if possible through central associations financed by small levies.

(6) Large consumers would be well advised to pay more attention to the system of buying and selling coal to a specification, and colliery owners would benefit the smaller consumers and, in the end, themselves, by classifying their coal so far as possible according to some agreed standards.

(7) Each District Coal Owners' Association, after reviewing the position of its members, should, in conjunction with the Electricity Commissioners, consider in what way the collieries of its district can take part in electricity development.

(8) The possibility of the use of low-grade fuel should be carefully considered when the site for any new electricity generating station is under consideration and when the plant for the station is designed, and the desirability of making any necessary adaptations of plant for the use of such fuel should be considered even for the existing stations.

(9) The coke oven owners should in many cases consider plans for reorganizing their oven plants as soon as possible into installations serving a number of collieries and

equipped with a modern type of oven. The question of the most suitable location of the plant also requires consideration.

(10) The Government should undertake an investigation in relation to a limited area such as that lying between the Humber and Liverpool and between Leeds and Birmingham, of the technical and economic aspects of an area gas supply system comprising an inter-connecting network of pipe lines fed by a number of gas-works, coke ovens, and the like.

(11) Every endeavour should be made by the mining and shipping interests and by the Government to further experiments in the use of high-pressure steam and pulverized fuel in ships of different types.

THE INSTITUTION OF GAS ENGINEERS.

Council Meeting.

A Meeting of the Council was held at 28, Grosvenor Gardens, Westminster, on Tuesday, Sept. 18—Mr. J. TERRACE (President) in the chair.

There were also present: Messrs. C. S. Shapley and H. E. Copp (Vice-Presidents), H. E. Bloor, T. Carmichael, R. E. Gibson, P. G. G. Moon, R. Robertson, H. C. Smith, and J. Wesley Whimster (Ordinary Members of Council); R. H. Ginman (Manchester District Institution), W. G. S. Cranmer (Midland Association), C. Valon Bennett (Southern Association), D. Walter Davies (Wales and Monmouthshire District Institution), H. D. Madden, J. Wilkinson, and Chas. F. Botley (Past-Presidents), and W. E. Price (Hon. Secretary).

Regrets at absence were received from Messrs. W. E. Caton, F. P. Tarratt, and W. W. Townsend (Ordinary Members of Council), F. Prentice (Eastern Counties Association), L. W. Dalby (Irish Association), J. W. Napier (North British Association), and Dugald Currie (North of England Association).

The President reported that he had received a letter from Mr. W. T. Dunn resigning his position of Secretary of the Institution, and the same was accepted.

The Council wish to place on record their appreciation of the long and faithful service rendered by Mr. Dunn, and the hope that his health will ultimately improve so that he may enjoy a period of well-earned rest.

It was announced that a telegram had been sent on behalf of the Institution to H.R.H. The Prince of Wales (Hon. Life Member) conveying loyal wishes for a successful tour to Africa. The appreciative reply of His Royal Highness was read.

The Council rose in sympathy at the intimation of the deaths of Mr. Arthur F. Bezant, late Editor of the "GAS JOURNAL" (Mr. Terrace, President, and Mr. Dunn represented the Institution at the funeral); Mr. S. Shadbolt, of Southbank, and Hon. George Swinburne, of Melbourne (Members).

Mr. R. H. Ginman and Mr. R. Robertson were appointed as Scrutineers of the balloting list dated August, 1928. They subsequently reported that the following had been duly elected.

For the Class of Member.

Harold Bunce Kendrick (Institution's 2nd Class Diplomé in Gas Engineering, 1928), Assistant Engineer, Gas-Works, Carlisle.

Herbert James White, Manager and Secretary, Gas-Works, Church Stretton.

For the Class of Associate Member.

Thomas Brittlebank Armitage, Distribution Superintendent, Cheltenham Gas Company.

Arthur Sydney Brush, Manager, Gas-Works, Amble, Northumberland.

Frederick Thomas Buist, Technical Assistant, Bankside Station of the South Metropolitan Gas Company.

Capt. James Carr, Assistant Engineer and Manager, Stretford and District Gas Board.

Harold Richard Hems, Chief Assistant, Industrial Heating Section, Birmingham Gas Department.

Thomas Mackie, Assistant Manager, Gas-Works, Kelty, Scotland.

The following were approved as candidates:

For the Class of Member.

W. C. Chapman, Engineer and Manager, Gas-Works, Boston.

Geo. Cox, Works Superintendent, Bankside Station of the South Metropolitan Gas Company.

Arnold Law, Engineer and Manager, Gas-Works, Limerick.

Frank Courtney Sylvester (Institution's 1st Class Diplomé in Gas Engineering, 1928), Technical Assistant, Gas-Works, West Bromwich.

For the Class of Associate Member.

William Leonard Ashman, Chief Assistant Chemist, Bath Gas Light and Coke Company.

Thos. Caldwell, Assistant Engineer and Manager, Widnes Corporation Gas and Water Works.

Thomas Moncur Duncan, Technical Assistant, Gas-Works, Perth.

Dennis William Lockey, Assistant Engineer and Manager, East Grinstead Gas and Water Company.

Joseph George Pope, Technical Assistant, Gas-Works, Workington.

Charles William Milward Rogers, Junior Assistant Engineer, Gas Light and Coke Company, Fulham.

Andrew Robin Wilson, Assistant Engineer and Manager, Gas-Works, Perth.

Mr. J. P. Thompson, of Barnoldswick, was transferred from the class of Associate Member to that of Member.

It was reported that the following had been elected as District Members of Council, on the Council of the Institution for the year 1928-29:

Irish Association of Gas Managers, Mr. L. W. Dalby, of Wicklow; Manchester District Institution of Gas Engineers, Mr. R. H. Ginman, of Leek; North British Association of Gas Managers, Mr. J. W. Napier, of Alloa.

Developments in connection with the application for a Royal Charter, which had been lodged with the Privy Council, were reported.

A letter with reference to the proposed standardization of gas retorts, received from the Refractory Materials Joint Research Committee, was referred back to that Committee for further consideration of the matter.

The President reported having attended, as representative of the Institution, a conference called by the British Engineering Standards Association to consider the question of setting-up a Committee for the Standardization of Road Signs and Traffic Signals.

The latest report on the progress of the liquor effluents research was received, and, after amplification by Mr. Botley, the Chairman of the Committee, was approved and adopted.

The Official Programme of the Fuel Conference of the World Power Conference, London, Sept. 24 to Oct. 6, was presented, and papers to be read dealing with the gas industry were approved.

In response to a request from the Federation of Gas Employers, the following Committee was appointed to consider the question of regulations for the working of purifiers:

Messrs. James E. Blundell (Carlisle), T. Carmichael (Portsmouth), J. Foster (Birmingham), J. W. Napier (Alloa), C. S. Shapley (Leeds), and F. P. Tarratt (Newcastle-on-Tyne).

The following nominations were received from the various Committees concerned, and were approved:

Corrosion of Pipes Committee.—Dr. J. S. G. Thomas, Messrs. Dean Chandler and J. G. Clark.

Calorimeters Committee.—Messrs. E. V. Evans and H. Hollings.

Gas for Therapeutical Purposes Committee.—Mr. W. W. Taylor, Alton Gas Company.

Benevolent Fund Committee of Management.—Messrs. J. W. Napier and W. W. Townsend (representing the Finance Committee).

Silica Research in Paris.

In a paper presented by M. H. Laedlein at the annual meeting of the Association Technique, we have further evidence of the progressive management of the Société du Gaz de Paris. It appears that in the immediate post-war years no clear line of action as regards the adoption of silica in gas manufacture could be gleaned from the mass of discussion taking place; and as the Company could not justify an attitude of passive resistance, they determined to define the subject for themselves. Accordingly they entered into careful research in 1921; and the work has continued ever since, to the great benefit of themselves and the gas industry in France in general. The Company have even gone so far as the actual manufacture of the refractories, which is carried out in well-equipped shops at the Landy Works. This section is self-contained, with the necessary offices, chemical and physical laboratories, test rooms, &c.; and the plant is now being enlarged. M. Laedlein states that the research work they have carried out has demonstrated that the gas industry can reasonably demand from the manufacturers of silica products retort sections which give practically no after-expansion.

WORLD POWER FUEL CONFERENCE.

The Technical Proceedings form a Later Section of to-day's "JOURNAL."

OPENING PROCEEDINGS.

The Fuel Conference organized by the British National Committee, with the approval of the International Executive Council, of the World Power Conference opened on Monday, Sept. 24, at the Imperial Institute, South Kensington, S.W. An official welcome was accorded by THE MARQUESS OF READING (the President of the Conference) to the delegates, who represented 48 countries; and Sir Robert Horne delivered an opening address.

The MARQUESS OF READING having welcomed the delegates,

Sir ROBERT HORNE, G.B.E., K.C., said it was not too much to say that no assembly of scientists had ever come together to discuss a matter more relevant to common everyday life, nor had any technical conference ever been held from which so many practical consequences which were vital to the prosperity of the countries represented might flow. Several industries which had sometimes been supposed to be antagonistic, and which, at any rate, bore a somewhat detached attitude to each other, were represented together for the first time, giving to each other freely the benefit of their investigations, and putting into the common stock of knowledge all that their researches had taught them.

The modern prosperity of Great Britain had been created by coal, and by coal the nation would be saved; but it would only be by adopting improved and more economical methods of using it, such as were foreshadowed in some of the papers to be presented to the conference. The pouring of raw coal in a crude state into furnaces and domestic grates must now be recognized as a tragedy from which they must find a way of escape.

He looked with most hope in this country to the development of some of the processes for the carbonization of coal at low temperatures. So many premature claims had been made for some of these systems that many people had lost patience because they were not in full operation on a large scale to-day; and sometimes blame was placed where no blame was due. But, as they all knew, a laboratory experiment was no test of commercial success, and unless they could follow up an experiment on a commercial scale, so as to yield a profit on the money that required to be invested in the operation, nobody was going to throw away his resources in carrying it further. Something like 400 processes had been tried. The difficulty had been to produce a semi-coke which could easily be consumed, both industrially and domestically, the value of which, along with that of the bye-products, would be sufficient to cover the cost of the process and the original raw material. He believed it could safely be said that they were at last emerging from the experimental stage and entering upon the industrial and commercial period of development in connection with some of these processes.

Waste heat from coke ovens, blast furnaces, and steel furnaces was now being turned to industrial use. In Germany and France great advances had been made in this direction, and much was to be learned from their experiences. Methods of producing synthetic liquid fuels were also engaging close attention, and suggestions were being made for the establishment of centres from which gas might be distributed over wider areas than had ever been thought of before.

Speeches in reply were then made, on behalf of the participating countries, by Dr. E. C. KOTTGEN (of Germany), Mr. O. C. MERRILL (Executive Secretary, Federal Power Commission, U.S.A.), Mr. B. F. HAANEL (Chief Engineer, Division of Fuels and Fuel Testing, Department of Mines, Canada), and Dr. M. KAMO (Professor of Mechanical Engineering, Tokyo Imperial University).

INAUGURAL BANQUET.

On Monday evening, in the Connaught Rooms, Great Queen Street, W.C., a large and distinguished gathering assembled at a banquet in connection with the conference. The Most Honourable THE MARQUESS OF READING, G.C.B., G.C.V.O., P.C. (the President of the conference), was in the chair.

At the call of the Chair, the toasts of "His Majesty the King" and "The Sovereigns of the Kingdoms and the Presidents of the Republics Represented" were enthusiastically honoured.

IT IS GOOD BUSINESS TO POOL KNOWLEDGE.

The Right Hon. Sir PHILIP CUNLIFFE-LISTER, K.B.E., M.C., M.P. (President of the Board of Trade), submitting "The Fuel Conference," said: It is a great pleasure to welcome the conference back again to London. It was four years ago that you had the first meeting, during the time of the Wembley Exhibition. That was a valuable and representative conference, but the conference that meets this week is far more representative even than that was. No fewer than 48 countries are represented on the present occasion; and from this country every fuel interest—direct and indirect—is represented among your deliberations, and your deliberations are as world-wide as your title. I think a world conference of this kind is a thing of real value to every country. We are at last learning that it is good business to pool knowledge ["Hear, hear"]—to pool it as within an industry, to pool it as between one industry and another, and last, but not least, to pool it as between one country and another. We are learning that general progress means general prosperity; and in no field is that truer than in the fields of fuel production, fuel consumption, and fuel research. Everywhere to-day the producers—whether they are producers of fuel or manufacturers—are facing the problem that unless they can find new outlets for what they produce, they are up against excessive capacity to produce and manufacture. Everywhere, in every country, fuel consumption—efficiency and cost—is an important factor. The advance of manufacturing and productive efficiency means greater output per man employed; and therefore unless we get a much greater consumption in every land, we cannot keep our growing populations fully employed. We therefore see the vital importance of cheap production, by which means alone more commodities can be produced and sold, and more people kept employed; and all this comes down very largely to the efficient use of fuel. The wide range of your deliberations shows that you appreciate this to the full. We are very wise to pool our knowledge. To-day every coal producing country wants to stimulate consumption. Therefore economical utilization, efficient grading, and new uses, are the common interest of all producing countries; and the greater the progress that is made in these directions, the greater will be the quantity of fuel consumed, and the smaller will be the competition between one country and another. But it does not end there. The interests of coal producers and coal consumers are largely identical. While absurd undercutting is bad for coal, and in the long run bad for industry, and should be stopped by organization within the coal trade itself, no far-sighted coal owner looks to combination as a means to force high prices on a static or diminishing market. He looks to combination as giving him the means, in mutual work with industry, transport, and power undertakings, to increase his sales and enlarge his markets.

A GAS GRID INQUIRY TO BE HELD.

It is a very fortunate circumstance that the publication of a most valuable report by the National Fuel and Power Committee, which I appointed some two years ago, should have been made at the time when this great conference is meeting. I have read that report with the greatest possible interest. I think it is full of valuable suggestions. One practical suggestion is made which invites immediate work, and to which I propose to devote immediate attention. The Committee suggest an inquiry into the use of surplus coke oven gas. They suggest that it might be worth while that an investigation should be put in hand—spread over some wide industrial area like that which lies between Liverpool and the Humber and between Leeds and Birmingham—in order to see if the gas undertakings in that area could not take a supply of gas from the coke ovens which already exist there, or which may be erected in the future. It is an inquiry well worth undertaking. You would have to see what is the consumption in that area, what gas is obtainable, what is the actual demand to-day and the prospective demand and supply in the future, and you would have to consider what it would cost to instal the necessary plant and connecting mains. You would certainly not be able to leave out of account the effect a development of that kind would be likely to have upon the coke producing industry itself and upon the market for coke. The Committee—a powerful and representative Committee—suggest that an inquiry on this scale could only be undertaken by the Government. I am here to say that the Government propose at once to undertake such an inquiry. [Applause.] I am sure that,

in undertaking it, I may count upon the co-operation of representatives of all the interests concerned—coal, gas, coke, iron and steel, and any others that may be affected—and I am going, as I have accepted that invitation so promptly, to make one request. I know that I can rely upon any members I may ask to serve upon that inquiry; but it will need also a competent, efficient, and experienced staff. I want to-night, in accepting that suggestion, to make an appeal to the industries that are concerned to supply to the Government a staff to conduct the inquiry. They have got the men who possess the necessary experience. It is a great national inquiry which ought to be undertaken; and I am sure that if I ask the industries to help with their staffs, they will readily give us the right men for the job. These men will perform a public work that no other staff, I believe, can adequately undertake; and after they have performed it, they will go back to their respective firms even more experienced and more valuable to the firms who have lent them to the Government. It is a form of co-operation for which I appeal; and I am sure that I have only to make the suggestion for it to be welcomed. [Applause.]

He concluded by remarking that the closer the great firms of this country can link their future developments and their researches with the Universities, the greater will be their success. Many great industries have already been most generous in their endowment of the Universities, which can be converted into a great asset, if they are used aright.

A Conference of Vital Importance.

Lord Reading, in response, said that, as the President of the conference, he had been deeply interested in what had fallen from the President of the Board of Trade. He was deeply interested in his country, and also in international affairs; and for this reason he rejoiced that the privilege had been conferred upon him of presiding over this conference and taking part in some of its activities. It was a matter of regret to Lord Melchett that enforced absence abroad had prevented him from presiding. He (Lord Reading) had considered various aspects of the problems with which the conference had to deal. They could all feel assured that, in the results which would ensue, there would be benefit to the industries which stood for so much in this country, and he hoped to the world at large. The conference was not only national, but it was international. They were all concerned in striving to increase production, while lowering the cost of it. No one could afford in these days to disregard the effect of science upon industry. They would set more value upon research as time went on. But there was another aspect of this great conference which had impressed itself upon him. Here 48 great nations, some of which were recently at war together, were meeting without regard to political differences, and were engaged upon a common object—not so much to add to a particular nation's assets, but to benefit the whole world. It was a great ideal, worthy of great men. It was an ideal the effect of which it was somewhat difficult to gauge.

"Our Guests."

Sir David Milne-Watson, D.L. (member of the Grand Council): I have had the great honour entrusted to me of proposing the health of our guests. It is a toast which really requires no words of mine to commend it to you; for I know that it will be received with the utmost sincerity and heartiness. Never have I more regretted than at this moment the happenings at the Tower of Babel, or wished that there was some common language known to all of us in which I could say how much we rejoice to have with us to-night so many distinguished friends from all parts of the world; how gladly we welcome them to London; and how much we hope that they will enjoy their stay among us; and that when the conference is at an end they will take away with them memories of their visit as happy and as lasting as those which we, their hosts to-night, took away with us after the sectional meeting at Basle, held under the able Presidency of Dr. Edward Tissot. On the occasion of the first meeting of the World Power Conference, which, as you all know, took place in London just over four years ago, we had the pleasure of welcoming the representatives of some 40 nations. To-night, despite the fact that we are assembled for a sectional conference only, and not for a plenary session, we have with us the representatives of 48 countries. This large attendance indicates that the conference is a real force meeting a real need. I can assure our guests that we shall do all in our power to render their visit both agreeable and profitable. The saying that "All work and no play makes Jack a dull boy" is one which must have a counterpart in some form or another in every tongue; and I confess that, as I study the programme of this conference, I feel that even the most greedy searcher after knowledge will find moments of relaxation necessary. Inasmuch as the authorities of the conference are responsible for the intellectual fare provided, it is they who must bear the blame for any intellectual indigestion which may ensue. It is for us, as hosts, however, to see to it that the necessary recreation is provided, and that our guests go to the meetings ready to partake fully and freely of the intellectual food provided for them.

Wide Significance of the Meetings.

The meetings of the World Power Conference have very great intrinsic importance. They also have a significance much greater than at first sight would appear. We are gathered from all parts of the world to discuss those matters which are of common interest to all of us; to hear from scientists and technicians of all kinds the latest advances which have been made towards the solution of each branch of the world's fuel problem; and to share one with another the discoveries which science and experience have revealed since last we met. Just as in every country there must be rivalry, competition, and conflict of interest between those directly concerned with the various branches of fuel production and supply, so, as between countries, there must necessarily also be rivalry and diversity of views and interests; but to the great benefit of ourselves and of the world at large, these are laid aside at our meetings, artificial geographical divisions disappear, and we become fellow workers in a great common cause. From our point of view the world is now a much smaller place than it used to be, and the interdependence of the various units of mankind which inhabit it is more and more being borne in upon us. No nation is, or can be, entirely independent; and so it is that conferences such as that on which we are about to embark are almost a necessary concomitant of the world's progress. They are necessary in our own individual interests, and also in the interests of the world as a whole.

But our meetings have another and wider significance. In discussing what I may call our domestic problems in a frank and friendly spirit, we learn much of each other's point of view, of each other's difficulties, and thus come to understand each other in a way which must necessarily have a beneficial effect upon our international relations. To-day, we all rejoice that the Pact of Paris has been adhered to by so many nations; and we rejoice to know that the League of Nations is constantly striving to secure world-wide peace and goodwill. I am, however, convinced that no greater impetus can be given to the cause of world peace than the meeting of men from all parts of the world to discuss their common interests. Such meetings are becoming increasingly common and increasingly important; and they must, in the very nature of things, tend to the creation of better relations and better understanding, and to the banishment of any atmosphere of suspicion and mistrust. Being the Fuel Section of the World Power Conference, we shall be discussing inflammable matters; but I have no hesitation in predicting that the only heat which will be generated will be the heat of enthusiasm for our work, and the heat required to weld still more strongly the happy bonds which already unite us. And if there should be any "waste" heat, let it be used for the softening of the sword, so that it may more readily be beaten into the ploughshare. [Applause.]

With the toast of "Our Guests" which I am about to ask you to pledge, I have the honour to couple the names of M. Guillaume (France), Mr. E. V. Hansen (Sweden), and Dr. Edward Tissot (Switzerland). M. Guillaume is, as many of you know, the President of the French National Committee of the World Power Conference; and he was the chief French Delegate at the first conference in 1924. During all his official career he was connected with the Department of Mines in France, and has only recently relinquished the post of Director of Mines. He is also an expert on synthetic fuels, and is the President of the National Nitrogen Association. In addition to the great technical knowledge and experience which he brings to the work of the conference, he has wide experience of international affairs. In Mr. Hansen we have another President of a National Committee—that of Sweden—and he, too, was his country's chief delegate at the first World Power Conference in 1924. His intimate knowledge of the problems of water supply for power and other purposes culminated in his appointment as Director-General of the Royal Board of Waterfalls—a post from which he recently resigned, to the great regret of his colleagues. Mr. Hansen also has an international reputation. He has been a member of the League of Nations since 1924; and as an engineer he has been honoured by the University of Dresden. Mr. Hansen is a loyal supporter of the conference; and to him, as to M. Guillaume, I express our special pleasure at seeing him once more in London. Dr. Edward Tissot is no stranger to us. He will be specially remembered as the President of the Basle Sectional Meeting of 1926, to which I have already referred. I was not privileged to be present at that meeting; but I have repeatedly heard from those who had the pleasure of attending that the organization of the meeting under the direction of Dr. Tissot was excellent, and that an extremely cordial reception was given to the British and other foreign delegates. He has set a very high standard, to which we shall strive to attain. Dr. Tissot is Vice-Chairman of the International Executive Council of the conference, and President of the Swiss National Committee. He is a Doctor of Science; and although since 1907 he has been Director and Managing Director of the Swiss Railway Bank, he has not severed his connection with the electricity industry, in which he began his career.

M. Guillaume, Dr. Tissot, and Mr. Hansen responded; and the proceedings concluded with the toast of "The Chairman," which was proposed by Col. R. K. Morcom, C.B.E. (member of the National Committee).

THE RUHR COKE OVEN GAS SCHEME.

A Review of the Present Situation.

Through past references in our columns, our readers are acquainted with the gigantic scheme under which the Ruhr coal interests are proposing to supply gas from their coke ovens through high-pressure mains to a considerable proportion of the whole of Germany. In our issue of Aug. 3, 1927, p. 279, we gave some technical details of the proposals, and a map which clearly showed the ambitious scale upon which the project was planned. It would, of course, necessitate the closing entirely of large numbers of gas-works, and the reduction of the remainder to the status of mere distributors, who would buy an almost purified gas in bulk from the coke ovens. Developments have occurred in recent times which it has been impossible to follow, since the whole matter is such a general topic in the German Daily Press that the Technical Press has little need to record what is happening. We have been fortunate enough to secure from a very esteemed correspondent, who, we know, can write with authority on the subject, a review of the present situation, of which the following is a translation.

[Communicated.]

The Limitations of Gas Supply in Germany.

In order to obtain, from the British standpoint, a clear understanding of the circumstances ruling in Germany, it is as well to consider for a moment the nature and the possibilities of the fuels in general use, and how they differ from those of the British Isles. For household purposes in Germany raw coal has gone practically out of use, and its place has been taken by coke, and, in Central Germany and the lower Rhine, by brown coal briquettes. Almost all large buildings and the better-class dwelling houses are provided with coke-fired central heating, and a large proportion of the modern houses have also coke-heated central hot-water supplies. The brown-coal briquettes, wherever they can compete from the freight point of view with coke, enjoy considerable popularity. They are cleaner both to handle and in use, and they are exceedingly labour-saving. The stoves in which they are burned are so constructed that the requisite number of briquettes (5 to 20, according to climatic conditions), is put in, and the stove closed. For twenty-four hours afterwards it needs no attention whatever, and then there is nothing to do except to remove with a shovel a large part of the ashes, which are in the form of a fine white powder, while a small glowing residue is left in to kindle the fresh briquettes. A German city to-day is, therefore, as far as private dwellings are concerned, entirely smokeless. Whatever smoke there is is due to the railways, and to the steam-raising plant of industrial works. Central heating and the brown-coal briquette stove work with great efficiency, so that, in contrast to England, gas fires can really only compete if gas can be supplied at approximately one-third of the usual price. There is little prospect of this being possible, as such a price would be well below the cost of production.

A similar situation rules in the heavy iron industry. The extent of its fuel requirements are well known, but it has so perfected its methods of using solid fuels that gas can only be substituted if it can be supplied not merely at very low prices, but also in great bulk. In small towns and in the country in Germany, gas consumption is likewise very low. It must not be forgotten that the supply of electricity to the agricultural industry, which is only now envisaged in England under the new Act, has long been an accomplished fact in Germany. Light and heat are offered to agriculture at a tempting price, and this results in an excellent revenue for the big overland electric supply corporations. For gas there remains only the cooking of food for man and beast; and, with great economy exercised by the country people, this is not a very profitable line. As an example may be quoted the East Saxon Gas Company which operates in the neighbourhood of Annaberg i. Erzgebirge. The Company supplies, through 530 miles of mains, 140 towns and rural districts with a total population of 90,000. The consumption amounts to no more than 5½ million cub.m. [194 million c.ft.], or some 60 cub.m. [2150 c.ft.] per head per annum. This is about one-fifth of the London figure.

Progress of the Ruhr Scheme.

The foregoing facts and figures will give some idea of the economic principles governing long-distance central gas supply. There is no denying that during the past year the Ruhr has been able to ensure for its grandiose scheme a very considerable gas outlet. A figure of 1000 million cub.m. [35,314 million c.ft.] is spoken of, though the bulk of this will no doubt be taken by the big iron and chemical works within the coal areas in Westphalia and on the lower Rhine. For the iron works especially it is an economic proposition when they can obtain gas at the original price of about 3 pf. per cub.m. [about 10d. per 1000 c.ft.] at which the Ruhr offers it to districts near the source. But no great progress has been made with contracts with the larger cities, except for Hanover, where special concessions appear to have been made. Negotiations, it is true, are in active progress with Cologne, but these are complicated by the fact that this city, with the avowed object of being in future independent of Ruhr coal, joined hands some time ago with the city of Frankfort in securing an important coal deposit on the lower Rhine. If, therefore, Cologne is to contract to take Ruhr gas, it will have, in some measure, to go back on its own past decisions. Certain interests in the city are inclined, all the same, to take this step. In addition to these advances, the Ruhr has signed a contract with one group of considerable size which intends to supply coke oven gas to the Province of Westphalia.

The Power of the Ruhr.

In considering the present situation, it is necessary to understand the enormous economic power which is concentrated on the Ruhr. The coal and iron interests which are centred there, and which are generally collectively referred to as the heavy industries, are so closely interwoven with syndicates and working agreements that they can be regarded as exercising to all intents and purposes a single will. And this will exerts great power both in political circles (a whole party is pledged to the interests of the heavy industries) and in the Press, in that quite a number of the more important papers are either absolutely in their possession or strongly under their influence. This power is wielded with remarkable energy and no little skill towards moulding public opinion for their own ends. No single day passes without some reference in the Press to distance gas supply, and almost always bearing upon the Ruhr scheme. Herein rests, naturally, a great danger for the gas industry, and a danger in several respects.

In the first place it is urged, again and again, that the coal and iron industries, just as in Great Britain, are in dire straits, and that therefore it is everybody's duty to the nation in general to help them by using their surplus gas. To the question as to whether it is really to the advantage of such and such city to use Ruhr coke oven gas, the reply is insinuated that it is the national duty of every German city to save the life of the heavy industries in this way. The line of thought is similar to that of Mr. Baldwin's recent appeal to English employers to assist in the problem of the workless, and in Germany it is proving infectious. For example, quite recently in North Germany a coke works connected with an iron foundry came out with the announcement that, owing to trading losses, they would have to close-down, and so add considerably to the numbers of unemployed in the district, unless the town could see its way to laying idle a newly erected up-to-date gas-works, and taking gas from the coke ovens.

A fundamental difference between the circumstances in Germany and in England is that German industry is not free to make its own way, but is bound by industrial courts, of which the Government itself is the supreme one, to such wages and social conditions as the Government desires. As this, as well as a majority of the National Assembly, is under the influence of the trade unions, the enactments of the courts are almost invariably in the direction of higher wages. The effect is, in fact, that any saving of costs due to improvements or rationalization in working is passed on to the employee. If, therefore, the Ruhr really has difficulties to contend with, these are, up to a point, the result of Government interference. In many cases communities, especially those at considerable distances from the Ruhr district, can claim that their own gas supply is no dearer than that offered under the big scheme, especially taking into account their large coke requirements, which would have to be drawn, at greatly increased cost, also from the Ruhr. Even so there is no little danger of their succumbing to political pressure which may be exerted upon them.

Price Policy and Propaganda.

Another great danger to the gas industry lies in the price policy of the Ruhr interests. As already mentioned, the whole scheme depends to a large extent upon supplying in great bulk to the heavy industries, which can only use gas at a very low price. In their contracts, they always endeavour to reserve for themselves the right to supply any big local industrial works direct with gas at whatever price they, the suppliers, wish. In this way the local gas-works, which, under the Ruhr scheme, buy in bulk and become the retailers of gas to the community, lose straight away their best source of revenue. As already mentioned, gas is used comparatively little in Germany for domestic heating and hot-water supply, so that the principal prospect of expansion for the gas undertakings is in industrial

supplies. If these have to be given at, or under, the bare cost of production, they must relinquish any hope of future prosperity. It would amount, in fact, to penalizing the householder and the small man in favour of the big industrial concern. This is a standpoint which might be justified in a few exceptional instances, where a whole town was dependent upon the prosperity of a single local industry, but in principle it is regarded by the German gas industry as unsound.

Another feature of the present agitation engineered from the Ruhr is the low gas prices which figure prominently in everyday discussions of the subject. It is not openly stated, but the public believes it can read between the lines, that the golden age for the gas consumer would dawn with the general adoption of the Ruhr scheme, in that gas could be retailed in any part of the country at 10d. to 1s. 2d. per 1000 c.ft. Quite openly it is put about that present gas prices in general are far too high. The uninitiated public are readily attracted by such ideas, but unfortunately also a number of influential manufacturing firms are beginning to take up the cry, and are demanding that the local gas-works supply them at the same prices as the Ruhr coke ovens supply their local affiliated iron and steel works. Such demands are commonly accompanied by the threat that, if they are not acceded to, the industry concerned will have to go where gas is cheaper.

INSENSATE COMPETITION.

Especially regrettable is the idea which is conveyed by the propaganda of the Ruhr interests that not only is an enormous increase in gas consumption attainable, but that it is there for the asking. The impression is thus created that there are profits to be made similar to those yielded by the central electric stations, with their current at about 6½d. per KW.-hour for lighting. Consequently feverish activity has developed in all sorts of directions. Anyone who is interested, or might be interested, in gas distribution is trying to cut and keep a slice of the big cake. The central electric corporations are endeavouring to obtain, by the granting of concessions in their own commodity, a monopoly of gas supply in the towns and districts which they serve. Whole provinces are joining together to control, in the hope of huge profits, the distribution of gas over large areas. Entire districts are dividing themselves into groups, with plans to close-down numerous small gas-works, and to distribute Ruhr gas through the works of a few big towns. The backwash of all this is hitting the big gas companies and municipal gas undertakings very hard. They had foreseen where the possibility of expansion lay, they had made their plans accordingly, and now they are hampered on all sides by the truly fantastic greed of those with whom they have to deal—namely, the authorities who own the roads, and the districts with which they wish to make contracts. It is only by making very considerable sacrifices and accepting all manner of irksome restrictions that they can make any progress at all. With the limited openings that exist for gas in country districts, as already explained, the prospects would be moderate enough without these fresh hindrances, which are merely the outcome of a misinformed public opinion. As an example may be quoted an agreement recently concluded, according to newspaper reports, between the towns of Leipzig and Halle, the Province of Saxony, and the German Continental Gas Company, of Dessau, for the supply of gas to a group of what correspond, more or less, to English counties. In this, the gas industry has obtained quite a minor concession; those whose normal business is not gas supply, with an entirely false idea of their vocation and their capabilities, retaining for themselves the lion's portion.

SUMMARY.

To sum up the situation as it is at present, it may be said that not only the Ruhr, but also the upper and lower Silesian coalfields, and the central German brown coal deposits will certainly succeed in finding a market for at least a part of their surplus gas. This will be of certain advantage to the coke ovens and the affiliated industrial concerns. The gain, however, will be no more than moderate, because gas prices are bound to be depressed by the embittered feeling which exists between the various groups in their competition for areas of supply. In the case of Cologne, gas is said to have been offered at less than 9d. per 1000 c.ft. delivered into holder. Besides the fierce competition between the various coal areas, there will be developments of distance gas supply, centring round the present modern gas-works of the big cities, on the system which is known in Germany as group gas supply. Large tracts of the country will, therefore, much sooner than would normally have been the case, be interlaced with systems of high-pressure mains. It remains to be seen whether the capital so invested will show any adequate return, or whether orderly development would not have been preferable to the present mad scramble after what may prove to be illusory gains. The principal sufferers are likely to be the present owners of gas-works, whether private or municipal, in that public opinion, swayed by the propaganda of the Ruhr interests, is trying to force upon them tariffs which, save in most exceptional cases, cannot be reconciled with their economic well-being. Even the "group" systems, which are being organized with all haste where this is a possible alternative to handing whole districts over to the coke oven scheme, cannot reckon upon any certainty of financial success, because of the price at which they have to offer their gas.

However unwelcome the whole development may appear, it has perhaps one salutary side for the gas industry. As an industry with a monopoly, it is always bound to have a slight tendency to rust. The present crisis has precipitated it into a life and death struggle, which will compel it to make the utmost use of every resource at its disposal. There can be no question that the individual gas-works and the group systems are deserving of every sympathy. If the heavy industries are to get into their own hands a monopoly of every kind of fuel—solid, gaseous, and liquid—there is no question that they will know how to use it to their own ends.

NEW GASHOLDER AT GRAYS.

Growth of the Grays and Tilbury Gas Company.

On Thursday, Sept. 13, the Chairman of the Company, Mr. Courtenay C. S. Fooks; the Deputy-Chairman, Mr. Alex. A. Johnston; and Mr. P. G. Gale and Mr. Worthington Church, Directors, attended Grays, where they were accompanied by the Engineer and Manager, Mr. A. W. Sumner, and the Secretary, Mr. Wm. F. Whittaker, for the purpose of putting into operation a new 3-lift guide-framed gasholder of 1,500,000 c.ft. capacity, which had been erected in order to meet the rapid growth of the Company's business.

The following figures show the remarkable growth of the undertaking since its incorporation in 1907:

Quantity of gas sold, 1907	63,726,400 c.ft.
,, ,, ,, 1927	319,076,300 ,,
Number of consumers, 1907	3,879
,, ,, ,, 1927	14,230
Quantity of coal carbonized, 1907	6,722 tons
,, ,, ,, 1927	16,562 ,,
Capital employed, 1907	£91,355
,, ,, 1927	£344,494

Dividends (interim) paid on Sept. 1, 1928: 10 p.ct. on the £10 "A" shares, and 7 p.ct. on the £10 "B" shares.

The Company was established as the Grays Thurrock Gas and Coke Company by Deed of Settlement in 1853, registered as the Grays Gas Company, Ltd., in 1884, and incorporated under its present name by Special Act of Parliament in 1907, when it was authorized to supply gas in the Parishes of Grays Thurrock, West Thurrock (which includes Purfleet), Little Thurrock, Stifford, Rainham, Aveley, Wennington, North and South Ockendon, East and West Tilbury, and Chadwell-St. Mary (which includes Tilbury Docks). By a further Special Act passed in 1913, powers were granted to supply gas in a largely increased district, and to acquire the gas-works which for some time had been established at Billericay, Rayleigh, Laindon, and Stanford-le-Hope. Under the powers of this Act the area of supply was increased to 160 square miles, and the Company now supplies gas through 145 miles of mains in this important and growing area.

THE HOLDER.

In 1926 the Company secured about 18 acres of additional land opposite their existing works in London Road, for the purpose of extending their works. The first extension has now been completed by the erection of the gasholder.

The foundations of the new holder were constructed by Messrs. W. E. Walsham, Ltd., of Grays, and consist of a reinforced concrete raft 146 ft. 6 in. in diameter. The holder, erected by Messrs. Samuel Cutler & Son, of Millwall, is constructed of the finest British steel, and consists of a steel tank 145 ft. in diameter and 35 ft. deep. There are three lifts, having a capacity of 1,500,000 c.ft., guided by steel lattice columns. The tank contains 3,379,800 gallons of water. The weight of the steel used in the construction of the tank and holder is 1000 tons, and the combined weight of the holder and water is 17,500 tons.

The work was commenced on May 11, 1927, and completed on Sept. 11 of this year; the total cost being in the neighbourhood of £30,000.

The whole of the work has been carried out to the approved plans and specifications of the Company's Engineer and Manager, Mr. A. W. Sumner, M.I.Mech.E. This is the third holder the Company has been called upon to provide during the past three years—one at Stanford-le-Hope, in 1926, having a capacity of 150,000 c.ft.; one at Rayleigh, with a capacity of 440,000 c.ft.; and the present one.

Additional gas-making and purifying plant has been installed on the old site at Grays (which now has an output of approximately 450 million c.ft. per annum) to meet the increasing demand for gas in the district.

NOTES ON NEW BOOKS.

"TECHNICAL DATA ON FUEL."*

In the programme of the World Power Conference on Fuel, London, 1928, there is to be found a Section X. which deals with the subject "Technical Data on Fuel." Coming after such specialized sections as the Carbonization Industries, Coal Cleaning, and Waste-Heat Recovery, it was rather difficult to picture how the Conference Technical Committee would deal with this subject of data. But now, with the opening of the Conference, the solution is at hand by the appearance of a book entitled "Technical Data on Fuel," edited on behalf of the Technical Committee by Mr. H. M. Spiers.

Before commenting in detail on this volume, it is necessary to consider what exactly has been the object of the Committee in its compilation. In the preface, it is stated that the volume has been written with the object of rendering available in handy form some of the information constantly required in the various branches of fuel technology. Data readily available have been omitted, and the selection of the subject-matter has necessarily been somewhat arbitrary; some of it being of general application and some of specialized character. From this it will be seen that the book is written essentially for those whose work brings them in contact with problems relating to fuel. It is written for fuel men by fuel men; and this is the first point that commends the volume to special consideration.

It will probably be agreed that, for a book such as this to be of real value, it must conform to certain requirements. It must be authoritative; it must be written in such a way that it can be understood; it must contain the kind of information likely to be required; and it must embody details of recent work. It may be well to review "Technical Data on Fuel" from these aspects.

First as regards its authority. From time to time, books have been presented containing technical data, but the present volume appears to have the unique advantage of being the result of the joint effort of the leading technical organizations which are connected with fuel. The information which is included is, in many cases, backed as to its reliability by practical evidence of certain of the collaborators. In other words, the book contains the data which are being used for design, research, and practical operation every day by such organizations as the Fuel Research Board, Imperial Chemical Industries, the Anglo-Persian Oil Company, and the Woodall-Duckham Companies.

The Technical Data Sub-Committee, through their Chairman, Dr. E. W. Smith, admit that there is no finality regarding the information published, and state that discrimination has been necessary in the choice of what may be regarded as reasonably accurate data. This is a frank admission. There can be no doubt that to have included alternative but conflicting data would have caused confusion, and by so doing would have reduced the value of the book to the man who requires data for helping him in a particular problem. If this collection of data is satisfactory to the various organizations which have collaborated in its compilation, it will undoubtedly be generally acceptable as a reliable working basis for technical men.

Information presented without adequate explanation is the cause of much waste of time and annoyance to anyone who tries to use it. It is, therefore, of interest to record that the Editor of "Technical Data on Fuel" has made a particular point of explaining the significance of the data he has included, and of describing the correct methods for their utilization.

The third point upon which the merits of a book such as this must be considered is the scope of the information included. The information is divided into the following main sections: General Information: Air Water, and Gases; Specific Heat; Steam and Refrigerants; Thermal Conductivity and Heat Transfer; Metals and Alloys; Refractories; Gaseous Fuels; Liquid Fuels; Solid Fuels; Stack Losses. It will thus be seen that the range of subjects covered is comprehensive, and perusal of the book shows that considerable care has been exercised in the selection of the data.

It is impossible to give adequate consideration to even the more important items included, but among the more notable features may be mentioned the very complete set of conversion factors. By this means, data which in certain tables are presented in English units may be converted into metric units, or *vice versa*. The subject of plain temperatures is dealt with in an original way by means of a series of charts. Valuable information is included relating to the properties and composition of modern motor fuels. Turning to the subject of solid fuels, there are included valuable data relating to the washability of coals. A useful selection is included of the properties of refractory materials.

Reference to publications as recent as August, 1928, shows the up-to-date nature of the compilation. For purposes of enabling the owner of the book to place any additional information he may acquire under its correct heading, the book has been largely interleaved with blank pages. There is also provided a good index with cross references.

For the actual preparation of this volume, the Technical Committee of the Conference state that they are indebted to Mr. H. M. Spiers, the Editor. He is certainly to be congratulated for maintaining throughout the book a lucid style, which makes it possible to understand the object and basis of the information he is presenting, and for the systematic arrangement of the contents.

This is, of course, the first edition of the book. With the passing of time it may be found necessary to modify certain of the selected material, and to strengthen other sections. Experience may also show that in certain cases the selection of data does not meet with general approval. For example, the choice of data on the specific heat of gases, by Goodenough and Felbeck, of Illinois, must be considered as rather unexpected. To the average engineer in this country it is also somewhat disconcerting to find the specific heat data expressed in metric units. To convert figures from metric units to British units takes time; and in this matter it would seem that the value of this section would have been increased by the adoption of the decision of the Institution of Civil Engineers in their Report of the Committee on Heat Engine Trials, 1927, in using Partington and Shilling's figures expressed in English units. This adoption of two sets of specific heat data in two authoritative volumes within two years emphasizes the great need for an international agreement on specific heat data for gases. Surely the subject is one upon which the World Power Conference might give a lead.

Again, as regards calorific values of gases, there is a certain amount of discrepancy between the figures used in "Technical Data on Fuel," the Institution of Civil Engineers' Report on Heat Engines, and The Institution of Gas Engineers' Fourth Report, 1920. The lay reader cannot sift the relative accuracy of the data, and he is left wondering whether to take the calorific value of methane, measured at 60° Fahr. and 30 in. Hg., as 995, 1000, or 992 B.Th.U. per c.ft. Here again there is need for agreement on basic information.

To sum up, "Technical Data on Fuel" is lucidly presented; it is authoritative; it is up-to-date; it is remarkably complete in its information; and it is cheap.

These attractions are sufficient to commend it to technical men in the gas industry, not merely for it to find a place on their bookshelves, but rather for it to be at their right hand to help them in their daily work.

*Edited by H. M. Spiers, M.A., B.Sc., F.I.C., on behalf of the Technical Committee, World Power Conference, 1928. Published by the World Power Conference, 36, Kingsway, W.C. 2. Price, 10s. 6d. net. Crown 8vo, 24 diagrams, 240 pages.

THE CERAMIC SOCIETY.

Refractory Materials Section.

The Refractory Materials Section of the Ceramic Society held their autumn meeting at Glasgow on Sept. 13 and 14—Mr. H. J. C. JOHNSTON, the Deputy President, in the chair.

The proceedings were diversified on the first afternoon by a trip down the Clyde on one of the Clyde Navigation's steamers, so that members could view the docks and shipbuilding yards from the water; and on the second afternoon by a motor run to Armadale, where members had the opportunity of looking through the Atlas Brick Works of United Collieries, Ltd. The plant and methods of working were well up-to-date, and produced a large output of firebricks and other refractories. The usual dinner took place at the Central Hotel on Sept. 13.

The programme of the meeting was varied as well as long, though it was announced that Mr. Dale's paper on "Aluminous Refractories and their Industrial Significance" was unavoidably postponed. The papers in the order presented were as follows: "Refractory Formers for Electric Heating Elements; Some Problems in their Manufacture and Use," by P. Cooper; "Notes on Refractories for Salt Glaze Kilns," by W. Emery and A. Johnson; "The Functions of Regenerators in Relation to the Refractories of the Construction," by A. T. Green; "Jointing Cements," by Cyril Edwards (Research Section, Woodall-Duckham Companies); "A Comparison of the Properties and Industrial Durability of Lime-Bonded and Clay-Bonded Silica Bricks," by W. J. Rees, B.Sc., and W. Hugill; "The Dissociation of Carbon Monoxide in Contact with Refractory Materials," by D. W. Hubbard, B.Sc., and W. J. Rees; and "Drying Cracks," by C. E. Moore.

THE INFLUENCE OF TEMPERATURE ON THE FLAME VELOCITY OF GASES.

K. BUNTE and A. STEDING.

[An Investigation at the Karlsruhe Gas Institute of the German Gas Association. "Das Gas- und Wasserfach," July 14, 21, and 28, 1928.]

(Continued from p. 598.)

CARBON MONOXIDE.

The quantity of carbon monoxide required for the test was about 700 litres, and this was obtained in as pure a state as possible from a chemical works. It contained about 1 p.ct. of nitrogen and slightly over 1 p.ct. of hydrogen. It was found by careful tests that the nitrogen had no effect at all on the flame velocity of the carbon monoxide. On the other hand, it was necessary as far as possible to reduce the hydrogen content, since even small traces of this were found to affect the results considerably, but a reduction below 0·662 p.ct. was found impracticable. It was therefore used in this state, and the effect of varying quantities of H_2 was tested later in order to arrive at estimated flame velocities for absolutely pure CO.

Dommer showed in his investigations that the moisture content of carbon monoxide affects considerably the flame velocity. When absolutely dry, it burns with great difficulty, and, owing to the instability of the inner cone, flame velocity readings cannot be taken. In the present work, therefore, the dry gas-air mixture was passed through a series of ten flasks filled with wet cotton wool. By this means saturation was achieved without any bubbling of the gas through water, which is apt to cause a flickering in the flame. The saturation flasks were contained in a thermostat, which, through a stream of water, was maintained at an even temperature of 11·4° C. The saturated carbon monoxide gave moisture readings of 1·44 and 1·34 p.ct. of water vapour, against the theoretical 1·32 p.ct. at this temperature.

Tables III. and IV. give the flame velocities, therefore, of this carbon monoxide containing 0·66 p.ct. of hydrogen and 1·3 p.ct. of water vapour. Again, as in the case of hydrogen in the last test, the flame velocities with normal and divided flame are equal. It will be observed, however, that there is a slight increase in the velocity between 800° and 900° in the "heated zone" test. It amounts to about 3 p.ct. at the maximum velocity. Between 900° and 1000° there is no further increase.

In an attempt to correct these figures to give values for a carbon monoxide entirely free of hydrogen, two further tests were made, with slightly higher percentages of hydrogen. In the first place, the original carbon monoxide with an "impurity" of 1·97 p.ct. H_2 was taken. The results are set out in Table V.

TABLE III.—*Carbon Monoxide containing 0·66 P.Ct. H_2 at Ordinary Temperature.*

CO. P.Ct.	V cm³/s.	Ordinary Flame.		Divided Flame.	
		h cm.	*u* cm/s.	*h* cm.	*u* cm/s.
70·9	35·0	1·73	20·1	..	..
62·7	39·6	1·10	35·0	..	..
56·6	43·8	0·97	43·4	0·97	43·4
51·6	48·1	1·00	46·3	1·01	46·0
47·2	52·6	1·11	46·1	1·11	46·1
43·9	56·5	1·24	44·4	1·24	44·4
41·0	60·6	1·40	42·6	1·40	42·6
37·9	65·3	1·58	40·9	1·58	40·9
36·4	68·1	1·72	39·4	1·74	39·0
34·5	72·0	1·89	38·2	..	..
69·2	33·1	1·37	23·8	..	..
60·8	37·7	0·91	39·6	0·95	38·1
54·7	41·9	0·89	44·8	0·89	44·8
49·6	46·2	0·95	46·6	0·95	46·6
45·2	50·7	1·07	45·9	1·07	45·9
42·2	54·3	1·22	43·4	1·22	43·4
36·7	62·4	1·56	39·7	..	..
32·7	70·1	1·97	35·7	..	..

TABLE IV.—*Carbon Monoxide containing 0·66 P.Ct. H_2 in a Heated Zone.*

CO P.Ct.	V cm³/s.	20°.		700°.		800°.		900°.		1000°.	
		h cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.
62·7	39·6	..	..	..	..	1·16	33·3	1·03	37·2	1·08	35·6
56·6	43·8	0·97	43·4	0·97	43·4	0·97	43·4	0·95	44·3	..	..
51·6	48·1	1·01	46·0	1·01	46·0	1·01	46·0	0·97	47·6	0·96	48·1
47·2	52·6	1·11	46·1	1·11	46·1	1·11	46·1	1·07	47·7	1·08	47·3
43·9	56·5	1·24	44·4	1·24	44·4	1·24	44·4	1·20	46·0	1·20	46·0
41·0	60·6	1·40	42·6	1·40	42·6	1·40	42·6	1·35	44·2	1·35	44·2
37·9	65·3	1·58	40·9	1·58	40·9	..	..	1·50	43·1	1·50	43·1
36·4	68·1	1·73	39·2	1·74	39·0	1·74	39·0	..	..	..	..
34·5	72·0	..	..	..	..	..	..	1·85	38·7	1·86	38·7
33·0	75·3	..	..	..	..	2·09	36·1	..	..	..	..
60·8	37·7	0·93	38·8	0·95	38·1	0·91	39·6	0·92	39·2	0·89	40·4
54·7	41·9	0·89	44·8	0·88	45·3	0·88	45·3	0·86	46·3	0·85	46·7
49·6	46·2	0·95	46·6	0·96	46·2	0·96	46·2	0·92	48·0	0·92	48·0
45·2	50·7	1·07	45·9	1·07	45·9	1·08	45·6	1·05	50·7	1·04	47·2
42·2	54·3	1·22	43·4	1·23	43·2	1·22	43·5	1·19	44·5	..	..
39·0	58·7	..	..	1·39	41·7	1·39	41·7	1·39	42·7	..	..
36·7	62·4	..	..	..	..	1·55	39·9	..	..	..	..
34·6	66·2	..	..	1·77	37·2	..	..	1·71	38·5	..	..
32·7	70·1	..	..	..	..	2·01	35·0	..	..	..	..
31·6	78·5	..	..	..	..	..	..	2·30	34·2	2·33	33·8
31·2	73·4	..	..	..	..	..	..	2·15	34·1	..	..
28·6	80·0	..	..	..	..	..	..	2·53	31·8	..	..

TABLE V.—*Carbon Monoxide with 1·97 P.Ct. H_2 in a Heated Zone.*

CO P.Ct.	V cm³/s.	Ordinary Flame. 20°.		900°.		1000°.	
		h cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.
62·7	39·6	1·02	37·5	1·01	37·9	0·98	40·5
56·6	43·8	0·89	46·9	0·82	50·4	0·81	50·9
51·6	48·1	0·92	50·0	0·83	54·8	0·83	54·8
47·2	52·6	1·02	49·8	0·95	53·2	0·95	53·2
43·9	56·5	1·14	48·3	1·07	51·1	1·08	50·8
41·0	60·6	1·27	46·7	1·20	49·4	1·20	49·4
37·9	65·3	1·43	45·1	1·34	48·0	1·33	48·3
36·4	68·1	1·57	42·9	0·48	45·6	1·48	45·6
34·5	72·0	..	..	1·66	43·2	1·66	43·2
31·6	78·5	..	..	2·06	38·2	2·06	38·2
60·8	37·7	..	..	0·80	44·3	..	..
54·7	41·9	..	..	0·74	52·6	..	..
49·6	46·2	..	..	0·80	54·4	..	..
45·2	50·7	..	..	0·91	53·2	..	..
42·2	54·3	..	..	1·05	50·1	..	..
39·0	58·7	..	..	1·19	48·0	..	..
34·6	66·2	..	..	1·53	43·0	..	..
31·2	73·4	..	..	1·90	38·5	..	..
58·4	35·6	0·71	46·2	..	..	..	..
52·3	39·8	0·74	50·0	..	..	0·65	55·6
47·2	44·1	0·84	49·4	..	..	0·75	54·6
42·8	48·6	0·97	48·1	..	..	0·90	51·5
39·6	52·5	1·13	45·2	..	..	1·05	48·5
36·7	56·6	1·27	43·5	..	..	1·20	46·1
34·5	60·3	1·44	41·4	..	..	..	..
32·5	64·1	1·67	38·1	..	..	1·57	40·4

It will be noted that the culminating point of the flame velocity curve at 900° and 1000° is about 10 p.ct. higher than at the ordinary temperature. In this case, also, there is no further rise between 900° and 1000°.

The next carbon monoxide tested had approximately 3·5 p.ct. of hydrogen. Here, parenthetically, may be recorded the noteworthy phenomenon with this gas that, without primary air, it burned with a faintly luminous flame. The colour of the flame was somewhat different from that of a gas containing hydrocarbons, and it might be described as almost flesh-coloured. With a gas-air mixture having 29 p.ct. of air (*i.e.*, excess of gas), the flame consisted of two cones one inside the other, with a surrounding secondary flame of flesh tint. The flame from the gas without air admixture deposited a soot on a cooled porcelain surface. This might possibly be explained as due to the intermediary formation of aldehyde and formic acid, having its origin probably on the rim of the outer cone.

The carbon monoxide with 3·5 p.ct. of hydrogen was tested for flame velocity at ordinary temperature and also at 900°.

TABLE VI.—*Carbon Monoxide with 3 5 P.Ct. H_2 in a Heated Zone.*

CO P.Ct.	V cm³/s.	Ordinary Flame. 20°.		900° First Gas Mixture.		900° Second Gas Mixture.	
		h cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.
70·9	35·0	2·20	15·9	..	..	..	..
62·7	39·6	0·96	39·6	..	..	..	..
56·6	43·8	0·78	52·8	0·74	55·0	0·73	55·7
51·6	48·1	0·80	56·5	0·76	59·2	0·75	59·7
47·2	52·6	0·89	56·6	0·84	59·4	0·83	60·0
43·9	56·5	0·99	55·0	0·96	56·5	0·96	56·5
41·0	60·6	1·14	51·6	1·09	53·9	1·08	54·6
37·9	65·3	1·30	49·3	1·25	51·2	1·24	51·4
36·4	68·1	1·45	46·4	1·41	47·7	1·40	47·9
33·0	75·3	1·80	41·6	1·78	42·2	1·76	42·6
60·8	37·3	0·78	44·8	..	..	..	..
54·7	41·9	0·70	54·9	0·68	56·6	..	..
49·6	46·2	0·77	56·2	0·72	59·5	..	..
45·2	50·7	0·87	55·3	0·82	58·4	..	..
42·2	54·3	0·99	52·8	0·96	54·3	..	..
39·0	58·7	1·14	50·2	..	..	..	..

Here an increase in the velocity was observed for all mixtures only between 800° and 900°.

The object of making the tests with various admixtures of H_2 was, if possible, to correct for absolutely pure carbon monoxide. In the graph in fig. 6 are plotted the culminating points of the flame velocity curves and the percentages of hydrogen "impurity."

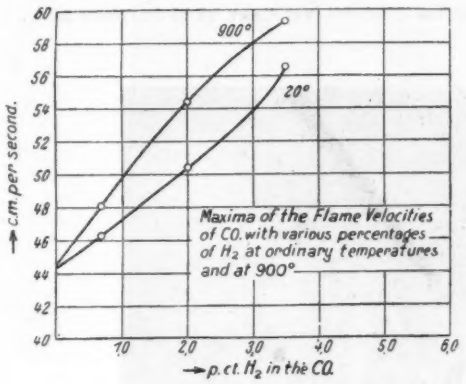
900°
20°
Maxima of the Flame Velocities of CO, with various percentages of H2 at ordinary temperatures and at 900°
c.m. per second.
p.ct. H2 in the CO.

Fig. 6.

The lines joining the culminating points of the curves for the three percentages of hydrogen (0·66, 1·97, and 3·49) were in both cases (ordinary temperature and furnace temperature of 900°) produced to ordinate 0, and thence the point of intersection determined.

Taking into account only the mixtures with 0·66 and 1·97 vol. p.ct. of hydrogen, and assuming the values with 3·5 p.ct. to have been influenced by subsidiary reactions, then with every probability of accuracy it may be stated that pure carbon monoxide undergoes no increase in flame velocity in a heated zone, and that the increase observed was due to the influence of the hydrogen impurity. In addition, at the point of intersection of the line joining the culminating points of the velocity curves at ordinary temperature and at 900°—that is to say with 0 p.ct. of hydrogen—a value for the maximum flame velocity of pure carbon monoxide can be read off. For a carbon monoxide with 1·3 p.ct H_2, it is about 44·5 cm. per second.

The change in direction in the line joining the individual culminating points indicates that between 2 p.ct. and 3·5 p.ct. of hydrogen there must be a change in the combustion process, though, without further research, no definite pronouncement can be made on the point.

Methane.

The methane which was available for the test contained considerable quantities of impurities in the shape of "heavy" hydrocarbons, hydrogen, carbon monoxide, and nitrogen. By condensation by means of liquid air, all the gases were liquefied except the hydrogen and nitrogen, which were thus eliminated. By fractional vaporization of the remaining liquid gases, a gas of the following composition was obtained.

CH_4	96·0 p.ct.
CO	2·0 ,,
C_mH_n	1·0 ,,
O_2	0·4 ,,
N_2	0·6 ,,
H_2	No trace

As the important point was to have a gas free of hydrogen, no further purification was attempted.

When burned in free atmosphere, the flame of methane gas rests only loosely upon the burner (fig. 7), and the slightest

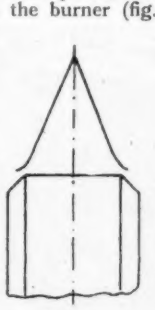

Fig. 7.

draught of air separates it from the burner. The base of the cone does not rest completely on the rim of the burner, and it is raised above it quite appreciably with high flow velocities. It is assumed that this is due to the drawing in of air at the base of the cone, since there is increased absorption of secondary air with increased flow velocities. That the entrance of air in this way actually does have an effect is clear, above all, from the fact that quite a number of gas mixtures give measurable flame velocities even when the proportion of gas is considerably above the explosion limit.

With divided flame, it is impossible to maintain a cone on the burner except at the maximum flame velocity and with comparatively low flow velocity. When methane is burned in a heated zone (*i.e.*, divided flame), the cone is stable only at the maximum of the flame velocity and beyond—that is to say, in the direction of increased proportions of air. With combustion in free air (*i.e.*, undivided flame) the curve can be followed on the side of excess of gas beyond the maximum. From this it is concluded that the ignition temperature of these gas-air mixtures is less easily attained than that of the gases already tested, carbon monoxide and hydrogen. A possible explanation is that, in consequence of the low gas content of the mixture, the quantity of heat released at the combustion surface is insufficient to raise also to the ignition temperature the high proportion of nitrogen in the reaction mixture, due to the high proportion of air. Only above a certain proportion of gas can regular combustion be maintained. With divided flame, indeed, combustion can take place only at the maximum of the flame velocity, because on the side of increased air there is a deficiency of heat from the secondary combustion, while on the other side the admixture of secondary air is constricted. This also explains why the flame in the heated zone is stable only on the side of excess air. In this case the inner cone receives heat from without, and so is able to continue the ignition of the fresh gas.

An attempt was made to avoid the lifting of the cone by raising the burner to a temperature of 50°. This effected no improvement, and apparatus was not available to try still further preheating, which would no doubt have had the desired effect.

In the flame velocity determinations, the distance of the apex from the upper rim of the burner was taken as being the height of the cone, since the position of the apex is not affected by the instability of the base in relation to the rim of the burner. It is only the parts of the mantle around the burner rim which are not in contact (see fig. 7). For all values, the space between the burner rim and the visible base of the cone was between 0·07 and 0·15 cm. From Table VII. it is seen that no increase in flame velocity was caused by the external heat. At a temperature of 1000° in the furnace, the cone was invisible, and consequently no reading could be taken.

Table VII.—*Methane in a Heated Zone.*

CH_4 P.Ct.	V cm³/s.	20° Ordinary Flame.		20° Divided Flame.		700°.		800°.		900°.	
		h cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.	*h* cm.	*u* cm/s.
16·35	37·90	2·75	11·90	..	..	..	*	..	..	..	..
14·75	42·00	2·49	16·90	..	..	..	..	..	..	..	..
13·55	45·70	2·28	20·10	..	..	..	..	..	..	..	..
12·50	49·50	1·93	20·70	..	..	..	..	..	..	..	..
11·60	53·40	1·67	31·80	..	..	..	..	..	..	..	..
10·90	56·70	1·58	35·60	..	..	..	..	..	..	..	..
10·35	59·90	1·63	36·90	..	..	..	..	..	..	..	..
9·80	63·30	..	†	..	..	..	..	..	..	..	..
11·70	35·90	1·17	29·80	..	..	..	*	..	*	..	..
10·50	40·00	1·05	36·90	1·07	36·50	1·05	36·90	1·06	36·70	1·08	36·00
9·60	43·70	1·18	36·00	..	..	1·17	36·30	1·21	35·20	1·26	33·90
8·84	47·50	..	†	..	..	..	†	..	†	1·56	33·40
8·17	51·40	..	..	..	..	..	..	..	..	..	*
13·20	17·05	..	..	..	..	..	*	..	*	..	*
10·60	21·25	..	..	..	..	0·49	36·80	0·49	36·80	0·51	35·80
9·80	22·95	..	..	..	..	0·54	36·80	0·59	34·70	0·60	33·80
9·40	23·95	..	..	..	..	0·61	35·30	0·68	32·40	0·70	31·60
9·10	24·75	..	..	..	..	0·67	33·80	0·77	30·10	..	..
8·80	25·55	..	..	..	..	0·76	31·40	0·84	28·80	0·88	27·60

* Cone unsteady at 1 to 2 cm. above burner. † Cone lifted from burner.

Technical Gases.

Passing over ethylene and the other components of the C_mH_n group, which forms only a small proportion of gases in general use, the authors turned their attention to the flame velocities of some of the most important technical gases. The common use in practice of the gas flame in furnaces and other situations where surrounding temperatures are high lends great interest to the tests carried out both under normal conditions and in the heated zone. The gases tested were:

1. Water gas.
2. Producer gas.
3. High-grade coal gas.
4. The town gas supplied at Karlsruhe.

(*To be concluded.*)

North of England Gas Managers' Association.—The autumn meeting of the Association will be held in King's Hall, Golden Lion Hotel, South Shields, on Friday, Oct. 5, at 2.15 p.m., when Mr. Dugald Currie, of South Shields, will deliver his presidential address.

MEETING DEMANDS AT BURY ST. EDMUNDS.

NEW HORIZONTAL CARBONIZING PLANT.

The continuous and consistent increase in the business of the Bury St. Edmunds Gas Company over the post-war period convinced the Directors that additions to the carbonizing plant would be necessary in the immediate future; and the scheme to provide these, which we are now able to describe and illustrate, was drawn up by Mr. Harry R. Wimhurst (the Engineer and Manager) and adopted by the Board.

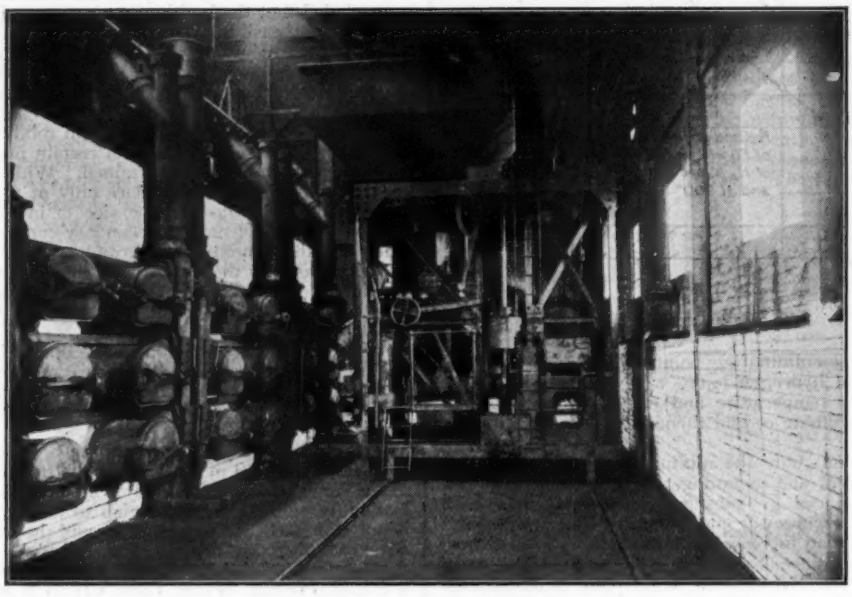

FIG. 1.—STAGE FLOOR ON MACHINE SIDE.

The plant in use at the time the extensions were decided upon consisted of three beds of eights, 22 in. by 16 in by 10 ft. long, and four beds of sixes, 19½ in. by 15 in. by 9 ft. long; the combined capacity being 320,000 c.ft. a day. The two benches of retorts were contained in one house; being placed on opposite sides, and facing each other. It will be readily understood that when the whole seven beds were in operation the working conditions in the house, with the system of hand-charging then in use, left much to be desired.

After an exhaustive survey of the numerous systems of carbonizing, it was decided, in spite of the confined site, to continue the use of horizontal retorts, with the addition of a com-

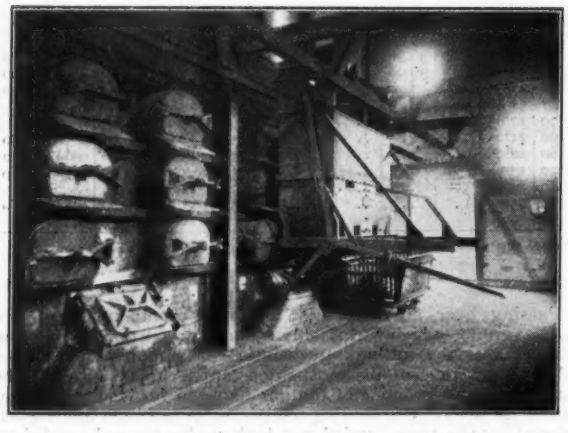

Fig. 2.—Stage Floor on Discharging Side.

bined charging and discharging machine and coal elevator. It was considered that this system was best suited to the particular local conditions. A scheme was drawn up by the Company's Engineer and Manager (Mr. Harry R. Wimhurst) for a plant capable of producing 336,000 c.ft. in 24 hours; and this was approved and adopted by the Directors.

The plant was to consist of a bench of four beds of through retorts, 24 in. by 18 in. by 15 ft. long. These were to be operated by a combined charging and discharging machine; and the elevator would deliver coal direct into the hopper of the machine. In this lay-out provision was made to extend ultimately the bench and retort house by the addition of three

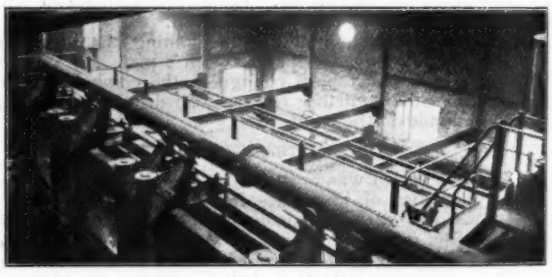

Fig. 3.—Top of Bench showing Foul Main.

more beds, at the same time adding overhead coal storage bunkers and a coal breaker. This extension would be made on the ground now occupied by the existing stop-end retort benches.

Orders were eventually placed in May of last year with Messrs. Aldridge & Ranken, Ltd., for a steel-framed retort house, stoking machine, coal and coke plant, retort mountings, and Congdon system; and with the Standard Furnace Company

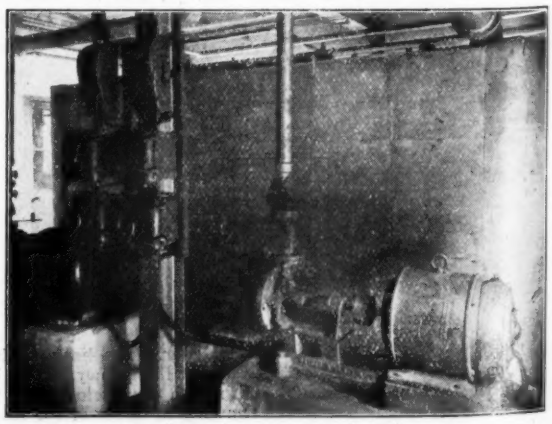

Fig. 4.—Congdon Tank and Pumps.

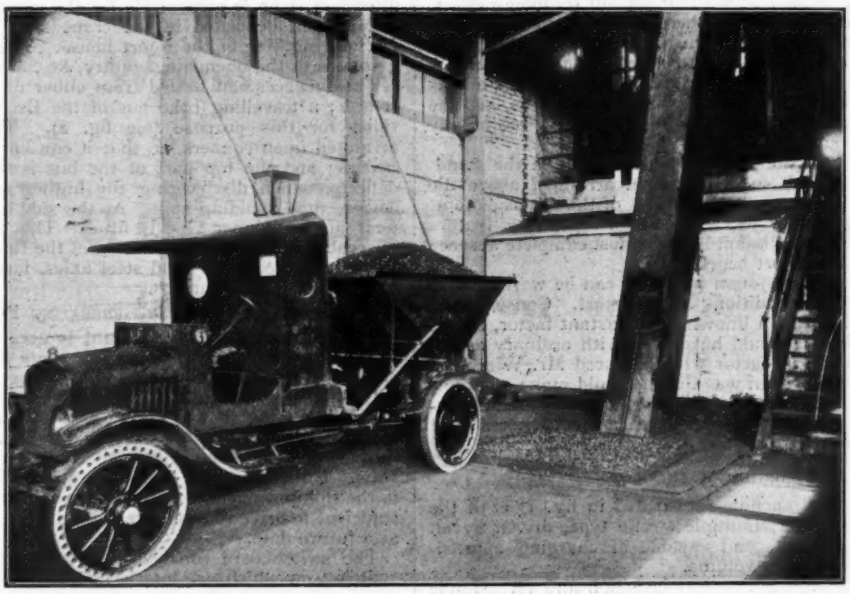

FIG. 5.—COAL LORRY AND BREAKER.

for the complete retort bench. The foundations were prepared by the Gas Company; and the brick filling of the house was carried out by a local contractor, Mr. J. H. Hales. The construction and erection of a steel chimney were entrusted to the local engineering firm of Messrs. Boby, Ltd.

RETORT HOUSE.

The retort house is steel framed with brick panels; the architectural features being made to agree with other new buildings on the works. From ground to stage floor level the panels are 9 in. thick, and from stage floor to eaves 4½ in. thick. The roof is covered with Trafford tiles, and the gable ends from eaves to apex with flat asbestos sheets panelled with oak straps and barge boards. The outside walls are of red brick, and the sills and "bulls' eyes" of pre-cast concrete.

The dimensions of the house are: Width between stanchions, 48 ft.; length, 59 ft.; height from clinkering floor to eaves, 32 ft. The stage floors are formed of concrete arches paved with blue chequer bricks laid flat and grouted with cement, and are provided with two staircases arranged in convenient positions.

BRICKWORK SECTION.

This consists of a retort bench of four through arches, each 8 ft. 9 in. wide; the main flue being arranged at the back of the furnaces and connected-up to a steel chimney of circular section. The four main arches are segmental, and the bench is built to a height of 21 ft. 9 in. above the clinkering floor level. Each of the arches contains six fireclay retorts of 24 in. by 18 in., ⌂ section, 15 ft. long; and each retort is made in two lengths. The furnaces are designed with special large grates of the latest hanging-bar type, with a view to reducing as far as possible the arduous work in connection with clinkering. Steel feeding frames (shown in fig. 2), with large rectangular mouths 24 in. by 15 in., are arranged to allow the producers to be fed quickly and efficiently. The fronts of the furnaces are securely braced by steel angles and channels.

The settings have proved capable of carbonizing 12 cwt. charges in twelve hours; but the weight has been reduced to about 11 cwt. (65 p.ct. retort volume) to enable the charges to be burnt off with combustion chamber temperatures at 1300° to 1350° C.

CONGDON SCRUBBER STANDPIPE SYSTEM.

In place of the ordinary arrangement of ascension pipes, the now well-known Congdon scrubber standpipe system has been adopted, with very satisfactory results. In this arrangement (which is shown in figs. 1, 3, and 4) all retorts in each vertical tier are connected to a specially designed standpipe; two standpipes being fitted to each bed of retorts. Special provision is made for expansion.

The principal function of these standpipes is partially to wash, cool, and scrub the gas immediately it leaves the retorts, and at the same time to ensure perfectly free passage for the gas to the collecting main, incidentally removing one of the bugbears of the gas industry—namely, stopped pipes. This is effected by injecting continuously at the top of the standpipe a suitable quantity of ammoniacal liquor, which, descending,

FIG. 6.—COKE GANTRY AND CRANE.

meets the ascending crude gas, with consequent scrubbing effect. A large proportion of the tar is thereby carried to a seal box at the foot of the standpipe, from which overflow pipes are arranged to take the liquor, &c., to a separating tank underneath the charging stage, where the tar separates out and is drawn off periodically. The tar gravitates to the wells, and the liquor is re-circulated through the system by an electrically driven centrifugal pump.

As will be seen from the photographs, the tops of the standpipes are connected to a collecting main arranged above the retort bench. The cleanness and coolness of the atmosphere at this level are very noticeable; while another pleasing feature of this portion of the installation is the almost complete absence of parts on top of the retort bench.

Another feature of this system is that it can be worked with practically level gauge conditions in the retort. Consequently the percentage of inerts is a known and constant factor, and is noticeably lower than it would have been with ordinary ascension pipes. An additional factor which induced Mr. Wimhurst to adopt the Congdon system was that he could make additions to his carbonizing plant without undertaking corresponding extensions to the ancillary plant, such as condensers and scrubbers, as the work upon these is obviously reduced.

CHARGING MACHINE.

The retort charging machine (illustrated in fig. 1) is of the Fiddes-Aldridge three-tier, multiple stroke type, driven by an electric motor of 10 H.P., and capable of charging approximately 70 p.ct. of the retort volume.

The machine is semi-simultaneous in action and very simple in operation; the coke being pushed out by a scoop, which at the same time takes in a charge, or "shot," of coal. This is subsequently followed-up by two further "shots," to complete the charging operation. The result is a perfectly level and heavy charge, suitable for twelve hour working with either fireclay or silica retorts. The machine is operated by a tramway type controller, and protected by a suitable and efficient circuit breaker.

LABOUR.

Two men per shift are employed in the retort house. The machine driver attends to the mouthpiece lids on his side of the house, and the man on the coke side wheels coke to the gantry. These two men also attend to the furnaces, coal elevator, and generating plant. The general appearance of the house, plant, &c., is extraordinarily clean, for which the Congdon system and "F.A." machine are largely responsible, though due credit must be given to the engineering and administrative ability of Mr. Wimhurst.

The lay-out of the new plant provides for the future addition of four more beds; and it is anticipated that only two men per shift will be required when six beds are at work. Consequently, the present maximum production of therms per man will be increased by 50 p.ct.

COAL HANDLING PLANT.

The coals so far used for carbonizing are a mixture of Yorkshires. These are received on the railway sidings about half-a-mile away, and are transported by a rather novel type of wagon (see fig. 5), which consists of a tipping body, having a capacity of about 25 cwt., mounted upon a standard 1-ton lorry. The carting of the coal is thus done expeditiously; and as the tipping body is easily removable, the lorries are available for other works duties.

The coal is delivered by this lorry directly into the store, or, to meet daily requirements, into the receiving hopper arranged at ground level at the base of the elevator. The elevator has a nominal capacity of 10 tons per hour; and by it the requisite coal is raised in the minimum time to the hopper of the machine, which holds sufficient for a "draw." This arrangement, while not ideal, saved capital expenditure on overhead coal storage hoppers.

The plant is so designed that at some future date a breaker and overhead storage hopper can be added. In the meantime, the coal used consists of washed nuts.

COKE HANDLING.

The hot coke is discharged into a bogie of lattice construction (shown in fig. 2), with side discharging doors. The bogies run on a 2 ft. gauge track laid under the mouthpieces; the wheels being fittted with roller bearings. The track on which the bogies are pushed is continued through the old retort house, and terminates in a gantry in the coke yard. At this point the hot coke is quenched; the quenching system consisting of the usual arrangement of perforated pipes, the water for which is raised by a steam jet water-lifter from a tank placed under the rail track. The tank is furnished with partitions and screens; the surplus quenching water passing back into the tank being thus filtered, after which it is re-circulated.

The quenched coke is discharged from the bogie into a skip fitted with automatic bottom doors. The skip is then handled by a ½-ton electric derrick crane, supplied by Messrs. James Carrick & Sons, of Edinburgh. The crane is fitted with a steel lattice jib 45 ft. long, which enables the coke to be stacked to a height of about 20 ft. over a considerable area of storage ground. It is operated by the boiler attendant, who is responsible for the storage of the coke after it has been deposited in the crane skip by the man on the discharging side of the retort house. The crane and skip, together with the quenching gantry, &c., are illustrated in fig. 6.

The furnaces can be fed from either of the two top tiers of retorts; a travelling coke bus of the Beckton type being provided for this purpose (see fig. 2). The chute portion is arranged upon runners, so that it can be brought clear of the bogies; and the top part of the bus is used as a shield and deflector when discharging the higher retorts into the coke bogies, thus avoiding spill. At the side of this bus, lid-lifting gear of the Kinner type is fitted. This facilitates, in a very agreeable way, the manipulation of the furnace lids. The coke bus is mounted upon mild steel axles, large diameter running wheels, and roller bearings.

ELECTRICAL GENERATING PLANT.

The electrical generating plant is accommodated in a commodious engine room beneath the stage floor on the charging side of the bench. For normal working, a 16 KW. 225 volt "E.C.C." dynamo, coupled direct to a Sissons vertical steam engine, running at 650 R.P.M., is provided. As a standby, a 16 KW. "E.C.C." motor generator is arranged alongside; this motor being connected to the town electrical supply of 400 volts. Either of these units is capable of supplying current to the stoking machine or coal elevator, with a margin of power sufficient to drive the coal breaker which it is proposed to instal at a future date.

The switchboard consists of two dynamo panels (the main switches on which are interlocked to obviate the possibility of the two dynamos being started simultaneously), and one circuit panel with connections to the stoking machine and coal plant. Should additional electrical power be required later on, space has been allowed for a third generating set.

Gas Consumption in California in 1927.

There was sold during the year 1927 to domestic and industrial consumers of California by the gas undertakings a total of 95,148,000,000 c.ft. of gas, including natural gas, mixed gas, and oil gas. According to the report of the Gas and Electric Division of the Engineering Department of the Railroad Commission, of this amount 72,391,000,000 c.ft., or 76 p.ct., was natural gas of approximately 1100 B.Th.U.; 620,000,000 c.ft., or 0·7 p.ct., was mixed gas of 700 B.Th.U.; and 22,137,000,000 c.ft., or 23.3 p.ct., was manufactured oil gas having a heat content of 550 B.Th.U. The domestic and commercial sales comprised 55·5 p.ct. of the total, while the industrial sales amounted to 44·5 p.ct. The peak day of consumption of gas during the year occurred on Dec. 21.

Mainlaying under Concrete Roads.

Desiring to lay a 6-in. main a distance of some 45 ft. under a concrete road (permission to open which could not be obtained), the Delaware Division of the Philadelphia Suburban Counties Gas and Electric Company resorted to boring. The method of procedure has been described in the "U.G.I. Circle." It was decided to use an 8-in. pipe for boring under the street—that pipe to be left in the ground to serve as a sleeve, and the 6-in. pipe to be run through it. To accomplish this a length of 8-in. steel pipe was made into an auger, and chain tongs were used to turn it, in order to cut its way through the ground. When the 8-in. pipe became filled with dirt and stones, a 6-in. auger was forced through to clean it. As the work progressed, additional lengths of pipe were welded to the 8-in. auger. When the 8-in. pipe was first converted to an auger, the blades measured 4¼ in.; but when the job was completed, they measured only 2¼ in. Normally, the boring could have been done in half the time required on this job (which was about four days); but work was made more difficult than ordinarily would be the case, due to the fact that the boring was through the old macadam road bed.

Manchester District Institution of Gas Engineers.—A meeting of this Institution will be held in Manchester on Wednesday, Oct. 17. In the morning a visit will be paid to the works of Messrs. R. & J. Dempster, Ltd., to view the new plant installed for the construction of waterless gasholders, and also work in progress in connection with this new type of holder. In the afternoon a paper will be read by Mr. William Buckley, of the Droylsden Gas-Works, on "The Maintenance Costs of Vertical Retorts."

Midland Association of Gas Engineers and Managers.—The autumn general meeting of the Association will take place at the Imperial Hotel, Birmingham, on Thursday, Oct. 11, at 2.30 p.m. Successful candidates in the Higher Grade Examinations of The Institution of Gas Engineers in Gas Engineering and Gas Supply will be presented with certificates. Mr. R. J. Rogers, Fittings Superintendent to the Birmingham Gas Department, will open a discussion on "Inspection and Maintenance of Consumers' Gas Fittings and Appliances;" and a discussion on "Gas Undertakings' Insurances" will be introduced by Mr. A. S. Foster, of Stourport.

World Power Conference.

Fuel Conference.

London, Sept. 24 to Oct. 6, 1928.

Carbonization Industries.

At the World Power Fuel Conference, which was officially opened on Monday last at the Imperial Institute, London, under the presidency of the Marquess of Reading, no fewer than 175 contributions are to be submitted. These papers come from all parts of the world, and each one is put forward with the authority of a technical body in the particular country from which the paper emanates. Forty-eight countries are supporting this international discussion, which aims at a better utilization of the world's fuel resources. With the idea of securing the maximum value from the sessions, it has been arranged that none of the actual papers will be read, but that instead of this there shall be presented a general report on the group of papers which is to come up for discussion at any particular session. For certain sections we shall confine ourselves to these general reports; but papers of more immediate interest to the industry will have extended notice. To-day we deal with those sections of the Conference which relate to the carbonization industries and the manufacture of gas; and in later issues of the "JOURNAL" consideration will be given to fuel utilization, low-temperature carbonization, the transmission of gas, and general coal treatment.

General Report of Section G: The Carbonization Industry—Economic and General.

By F. S. TOWNEND.

For the purpose of this general report the twelve papers may be grouped as follows:

TECHNICAL ASPECTS.

Heat Transfer through the Walls of Coke Ovens (Germany), by K. Rummel.
The Use of Gross and Net Calorific Values for the purpose of Guarantee Tests (Germany), by N. F. Nissen.
Coke Quenching and Cooling (Great Britain), by W. Colquhoun.
Coke Screening (Great Britain), by W. S. Edwards.

ECONOMIC CONSIDERATIONS.

The Economics of Coke Manufacture in the Coke Oven Industry (Great Britain), by M. Mackenzie.
The Utilization of Coke Oven Gas by the Gas Industry (Great Britain), by T. P. Ridley.
The Gas Industry as a Source of Domestic and Industrial Energy (Great Britain), by F. W. Goodenough, C.B.E.
The Bye-Product Coke Oven as a Source of Industrial and Domestic Energy (Great Britain), by C. P. Finn and R. Ray.
Points of Importance for an Economical Comparison of the Value of the Heat Unit in Gaseous and Solid Fuels (Germany), by Hr. Elvers.

CARBONIZATION AS NATIONAL ECONOMY.

The Bearing of High and Low Temperature Carbonization and Synthetic Fuel Processes on Canada's Fuel Problems (Canada), by B. F. Haanel.
A Brief History of the Gas Industry in Japan (Japan), by Sakura Okamoto.

FLAME AND COMBUSTION.

The Fundamental Aspects of Combustion (Great Britain), by Prof. W. A. Bone, Prof. G. I. Finch, and Dr. D. T. A. Townend.

TECHNICAL ASPECTS.

Two aspects of carbonization technique are dealt with in the first group—namely, guarantee tests and coke preparation.

Guarantee Tests.—K. Rummel, in the paper on "Heat Transfer through Coke Oven Walls," questions the validity of stating the performance of a coke oven in the terms of production of coke per square metre of heated wall area per hour. This depends too much on the inherent nature of the coal and the form in which it is charged into the oven. The only criterion of the performance of a coke oven is the proportion of the total heat supplied to the oven as fuel gas which is passed through the walls. It is suggested that the efficiency of a coke oven should be recognized as:

$$\frac{\text{"Effective heat" (heat passed through walls)}}{\text{Total heat supplied as fuel gas.}}$$

The "effective heat" is obtained by determining the radiation and convection losses and the heat in the waste gases, and subtracting the total from the amount of heat supplied as fuel gas. Two ovens giving the same proportion of effective heat would have the same efficiency, though the production of coke per sq. metre of heating surface per hour might be different owing to the different heat requirements of the two coals.

It is further suggested that the performance of a coke oven would be adequately represented by the following guarantees:

(1) Good oven efficiency.
(2) High consumption of fuel gas per hour per cubic metre of chamber volume with a definite wall temperature.
(3) Very small temperature differences in the medium plane of the coke mass.

That an official decision as to the form and extent of coke oven guarantees is required, cannot be doubted. Whether the proposals in the paper under discussion are the most suitable is a matter for discussion.

In the same paper experimental determinations of the heat

stored up and released by coke oven walls during a coking period are described. This may reach the high figure of 17,500 kilogramme calories per sq. metre per hour. It is therefore essential that the guarantee test should be run under such conditions of temperature control and for a sufficiently long period as to render this effect of little or no influence.

N. F. Nissen, in "The Use of Gross and Net Calorific Values for the Purpose of Guarantee Tests," gives figures which show that comparisons of efficiencies of boiler plant based on gross calorific values may be entirely different from those based on the net values. Since 1925 a two-year period was officially introduced in Germany where both terms would be used side by side. No official decision has been reached; but in spite of the fact that the net calorific value is not capable of so precise a definition as the gross calorific value, there is an increasing tendency towards the adoption of the net value for calculating boiler efficiencies.

Coke Preparation.—In the technique of coke production great interest is being taken in the preparation of the coke after it is removed from the carbonization chamber; and in the papers on "Coke Quenching and Cooling" and "Coke Screening," accounts are given of the progress which has been attained in these two branches respectively.

It would appear from W. Colquhoun's paper that, of the methods in which water is the cooling medium, the method of "remote" quenching used at most American plants and now coming into vogue in Great Britain and the Continent is most suitable for modern high-speed coking plants. It can produce a quenched coke with a constant amount of water of about 2 p.ct.

Blast furnace operators, while not minimizing the desirability of a *dry* coke, are demanding that whatever its moisture content is, it should be *constant*. It would seem that, providing this requirement is maintained, the practice of water quenching may not be entirely superseded. Nevertheless, there is a decided interest in schemes of dry cooling by which a perfectly dry coke can be obtained. The necessary plant is high in first cost, and a satisfactory credit for the steam raised is essential for the installation to be an economic proposition. W. Colquhoun gives typical conditions under which the credit for steam far outweighs the increased capital charges of the dry cooling plant. An additional advantage claimed for dry cooling is that there is a greater proportion of saleable coke.

W. S. Edwards points out that it is only recently that the special nature of coke has been taken into account in designing screening plant. As an example of the present unsatisfactory state, it is stated the type of screen probably most widely used for coke screening depends on the same principle used in knocking out sand from castings, in the tube mill for grinding, and in the "Bradford" coal breaker. Special attention is called to the importance of careful consideration being given to the method of handling the coke after leaving the screens. Emphasis is laid on the disadvantages of over-rating screens, and it is stated that "when installing new plant for preparing coke for the modern market, it pays to be liberal in design. The demand for a properly sized coke is growing more exacting every day, and higher prices are paid without demur for a first-class product."

Economic Considerations.

Four of the five papers grouped under this heading deal with the coking industry and the gas industry of Great Britain. M. Mackenzie, considering "The Economics of Coke Manufacture in the Coking Industry," indicates that the present economic stress in Great Britain is leading to a radical rehabilitation of the iron and steel industry, on which the prosperity of the coking industry so largely depends. While the modern coke oven has a high first cost, the conversion costs are approximately the same as with waste-heat ovens in 1913, and are some three shillings cheaper than with waste-heat ovens to-day. In labour cost alone the cost per ton of coke is reduced on modern regenerative plants from 3s. 9d. to 1s. 9½d. A plea is entered for a more extensive and uniform method of arriving at the costs of operation.

Unification.—Reviewing the situation, attention is drawn to the advantages of unification and the bulk supply of surplus coke oven gas. M. Mackenzie is of the opinion that widespread "concentration of coking units which does not form part of a larger scheme of unification and rationalization of our principal iron and steel producing plants may defeat its own object." This, however, will require a large capital expenditure, as the present building costs for steel works are at least double those of pre-war days. It may be pointed out that this would, as in Germany, give a certain outlet for the surplus gas to the steel works; and the question may be permitted whether, in view of the present economic stress, such concentration cannot be afforded.

Unification of coking units on the grand scale is considered by M. Mackenzie to be feasible only when a user can be found for the surplus gas. The supply in bulk to the gas industry, provided adequate safeguards are given, is a question between the interested parties.

Bulk Supply of Coke Oven Gas.—In natural sequence is a consideration of T. P. Ridley's paper on "The Utilization of Coke Oven Gas by the Gas Industry." The progress both in actual sales and in the technique of gas production of the gas industry may be observed in that during the last twelve years the sales of gas have increased by 32 p.ct. and the make per ton of coal by about 29 p.ct. Naturally the gas undertakings are concerned to maintain this progress, and take the standpoint that "if coke oven gas can be supplied . . . on terms and conditions which will enable gas to be sold to the public at lower prices than would otherwise be the case, there is no reason why the utilization of such gas by the gas industry should not extend; on the contrary, it should be welcomed."

References are made both by M. Mackenzie and T. P. Ridley to the German scheme for bulk distribution of surplus coke oven gas; and it may be of interest to draw from them a comparison of conditions as between Germany and Great Britain. In the first place, the gas industry in Great Britain is greater than that in Germany, while as regards the coking industry, precisely the opposite is the case. Moreover, the steel works in Germany absorb a large proportion of coke oven gas; and it is only that amount surplus to the coke ovens at German collieries which is available for use in the German gas industry. In Great Britain, only a comparatively small amount is absorbed by the steel industry. In Germany it is proposed to use the gas for the synthetic production of sulphate of ammonia, oils, and methanol, and for hydrogenation of coal. The possibility of similar applications in Great Britain depends mainly on the cost of production as compared with the existing market prices. The German scheme of long-distance gas supply has in view the object of cutting out the import of foreign coal. This latter factor tends to make the cost of production of gas higher on the average than in Great Britain, and renders more feasible the supply of gas over long distances. Such a politico-economic factor as imported coal has no place in Great Britain.

Reverting to T. P. Ridley's paper, a detailed statement of the statutory obligations of the British gas industry is given, and it is stated that in Germany there are no special Acts of Legislature regulating the supply of gas. It would seem that the liability to these legislative penalties undoubtedly impels the requirement of adequate and stringent safeguards before the British gas industry would undertake commitment to dependence on coke oven gas.

In spite of this it is interesting to note that, with the new contracts in 1929, the British gas industry will be absorbing approximately the same amount of coke oven gas as is at present being supplied to the German gas undertakings by coke ovens in the Ruhr.

From an examination of the possible amount of coke oven gas available in England, T. P. Ridley concludes that "if all the coal at present carbonized in waste-heat and regenerative coke ovens were carbonized in compound ovens, there would not be nearly sufficient surplus gas produced to meet the total town gas sales of Great Britain.

In determining the price which the gas industry can afford to pay for a coke oven gas, a list of the charges still to be borne by the gas undertaking is given by T. P. Ridley, and consideration is given to the two schemes—whether the coke ovens supply a constant load, the gas-works meeting the peak demands; or *vice versa*. The economic price permissible will vary with such conditions.

Carbonization as a Source of Domestic and Industrial Energy.—The contribution of the carbonization industries as sources of domestic and industrial energy is dealt with by C. P. Finn and R. Ray for the coking industry, and by F. W. Goodenough for the gas industry. The latter shows that if raw coal be carbonized, and the coke be converted into electricity, then as gas and electricity there would be available about 115 therms per ton, whereas if the raw coal had been burnt directly for electrical generation, only half that amount, at the most, would have been available. It is further estimated that if the 1125 million therms of gas used in 1927 for domestic and general fuel purposes had been replaced by burning raw coal, an extra 11 million tons of coal would have been consumed. The contribution of the gas industry to smoke abatement need not be stressed. The gas industry is looking for freedom from the existing, and in many respects antiquated, legislative restrictions, thereby hoping to make the use of gas still more attractive to domestic and industrial users.

Carbonization as National Economy.—According to S. Okamoto, in his paper "A Brief History of the Gas Industry in Japan," after considerable fluctuations in prosperity, the Japanese gas industry is progressing, in spite of the expansion of the electrical industry. This is put down to the loosening of restrictions as to increases in the price of gas, more scientific management, and—probably not the least important—the advance in the standard of living and the increasing cost of competing fuels.

Canadian Problems.—Canada, though possessing fuels of almost all kinds within her confines, stands in the position of importing a very large proportion of her fuel requirements. B. F. Haanel, in "The Bearing of High and Low Temperature Carbonization and Synthetic Fuel Processes on Canada's Fuel Problems," states Canada's fuel problem as the provision of a solid fuel for domestic heating and liquid fuels from home sources to render herself free from dependence on foreign supplies. This demand may be met by high-temperature carbonization, low-temperature carbonization, and synthetic fuel processes. High-temperature coke is acceptable in every way as a solid fuel for Canadian conditions, and the gas produced is

readily disposed of to communities. This method of carbonization leaves almost untouched the problem of a supply of oil, and does not avoid the importation of foreign coal.

The increased yield of oil in low-temperature processes would permit of only a small proportion of the oil requirements being met within a large over-production of coke. It is the opinion of B. F. Haanel that the present prices of high-temperature coke and crude petroleum oil, which would govern the values of the two chief low-temperature products, are so low that low-temperature processes in Canada are uneconomic unless the plants are extremely cheap both in first cost and in operation charges.

There remains the possibility of utilizing synthetic fuel processes. While such processes may have reached some considerable degree of technical development, the cost of the resulting liquid fuel is too high in comparison with the price of crude petroleum oil. The recent improvements in cracking processes, however, have made it possible to contemplate the commercial recovery of oil from the large reserves of oil shales.

Flame and Combustion.

In their paper on "The Fundamental Aspects of Combustion," Profs. Bone and Finch and Dr. Townend indicate the present state of knowledge and the directions in which research is leading. From the point of view of the Conference, the section dealing with the problem of "knock" in petrol-air engines is probably of most immediate interest. It is indicated that if the compression ratio could be increased from 5 : 1 to 7 : 1, the efficiency of a petrol engine should be increased by about 14 p.ct. Petrol fuels unfortunately have a very marked tendency to "knock" under increased pressure ratio. Aromatic hydrocarbons and alcohol are comparatively free from this defect; and indeed, by diluting petrol fuel with benzole, the tendency may be diminished. A range of substances which suppress in varying degrees the tendency to "knock" are known, of which lead tetra-ethyl is the most potent. The cause of "knocking" and also the precise explanation of the behaviour of "anti-knocks" are still undecided.

Agenda.

From the papers which form the subject of this general report, the following agenda appears to cover the outstanding features which may be worthy of discussion: The scope and determination of coke oven guarantees; coke preparation, practice and economics; unification of the coking industry, co-ordination with steel plants, feasibility and economic advantages; bulk supply of coke oven gas, determination of economic price, safeguards for the gas industry, outlets other than the gas industry; and carbonization as national economy.

Coke Quenching and Cooling.

By W. COLQUHOUN.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

[Extract.]

The constitution of good blast-furnace coke is a subject of discussion as old as the iron industry itself. It is brought into new prominence in the coke oven industry as well as in the gas industry by the realization that coal of good quality is no longer cheap and abundant. Therefore a better knowledge and control of the production of the coke derived from it has become an economic necessity which has given birth to great activity in investigating all the means of the efficient and economic manufacture and use of coke.

Among the subjects dealt with at this conference the present communication is concerned only with the subject of quenching and cooling coke. Let us consider first the method of quenching with water, in common use since earliest times.

Quenching with Water.

Coke Wharf.—A flat wharf has been greatly used, and is still to be found in many of the early plants in use in England and on the Continent. When the coke is passing out of the oven the mass is pulled down right and left with hooks and quenched with the hose. Sufficient time is allowed for the coke to steam off and cool, before being loaded into wagons.

Tests made at various installations show conclusively that dry-cooled coke is more resistant to shock and abrasion than water-quenched coke. The following comparison[1] may be taken as typical. It relates to a Saxony coal coked at the Keilehaven Gas-Works, part of a batch being water-quenched, and the other part dry-cooled, and then tested for abrasion by a *trommel* method.

Sizing.	Water-Quenched Coke.	Dry-Cooled Coke.
0–10 mm.	18·00	14·10
10–25 ,,	15·60 } 53·8 p.ct.	12·64 } 37·14 p.ct.
25–40 ,,	20·20	10·40
40–60 ,,	16·00	7·60
60 and over	30·20 } 46·20 ,,	55·26 } 62·86 ,,

These figures show that dry-cooling yielded 36 p.ct. more saleable coke than wet-quenching, and that the coke breeze was 31 p.ct. less in quantity.

At another test at the Keilehaven Gas-Works, the coke was larger and the amount of breeze reduced by dry-cooling:

—	Wet-Quenched.	Dry-Cooled.
	P.Ct.	P.Ct.
Large	50	67
Medium (1½ to 2½ in.)	21	17
Small	17	9
Breeze	12	7

This superiority in coke quality may be attributed to gradual cooling, as opposed to the sudden shock of contact with water; the coke is shattered by the resulting miniature explosions of steam in the pores and fissures. Over a long period the breeze was reduced[2] by nearly one-half—*i.e.*, from 14 p.ct. to 8 p.ct. of the total coke handled—as compared with the wet quenching previously practised.

Sulphur in Dry-Cooled Coke.

It has been suggested that the action of steam on the sulphide in hot coke reduces the sulphur in water-quenched coke. Careful experiments were carried out at the Mathias Stinnes Collieries to determine the differences, including sulphur content, between water-quenched and dry-cooled coke. The report[3] made by Dr. Müller was limited to the physical properties of the coke (which are favourably commented upon), and excluded the question of the economical side of the process. Discussing the influence of the process on sulphur content, samples of water-quenched and dry-cooled cokes respectively were taken from the middle of a batch from the same oven. The total sulphur in the dry coal was 1·2 p.ct.; the dry-cooled coke contained 0·914 p.ct. of sulphur, and the water-quenched coke 0·857 p.ct.—a difference of 0·057 p.ct. Considering how small a proportion of the sulphur in the coke comes down to the tuyeres in the blast furnace, and that the sulphur exists chiefly as alkaline earth sulphides that are absorbed in the slag, its influence upon the sulphur contents of the iron made is negligible. Proof of this is obtained on an industrial scale at the blast-furnace plants that have been erected. For example, the furnaces at Homécourt are fed exclusively with dry-cooled coke, and the quality of the iron produced has been in no way affected, while, according to Dr. Müller, the coke consumption has been reduced by 4·17 p.ct

Incidental Advantages of Dry-Cooling.

The dry-cooling method dispenses with the water troubles familiar to every coke maker who quenches with water. The water is then spoilt for any other purpose and, owing to the supply being usually limited, in nearly every case it has to pass through settling tanks, where the breeze is reclaimed by one means or another, and the water has then to be pumped into circulation or into high-service tanks. The deterioration of ironwork due to the clouds of acid vapours is avoided. In a coking plant there is some escape by using remote quenching, but in a retort house the effects of quenching with water are highly destructive.

Dry-cooled coke, as compared with water-quenched coke containing, say, 7 p.ct. of water, has a proportional advantage in cost of transport which, even for moderate distances, may amount to a considerable economy at the existing high railway rates. Thus the buyer has to pay carriage on 70 tons of water in every train-load of 1000 tons.

Economy of Dry-Cooling.

The published cost of steam in eight Government factories has been assembled by Mr. Parrish;[4] and the item of fuel, taking boiler coal at £1 per ton, ranges in cost between 28d. and 43d. per ton of steam made. The average figure is 35·5d.

[1] Carried out by the Erzgebirgische Steinkohlen-Aktienverein, and reported in the Monthly Bulletin of the Swiss Gas and Water Engineers' Association, Vol. IV., No. 10.

[2] Sissingh. "Gas- und Wasserfach," 1923, pp. 735 *et seq.*; "Gas World," Coking Section, July 5, 1924, p. 17.

[3] Dr. F. Müller, "Glückauf," Aug. 28, 1928, pp. 1128-1132.

[4] "The Design and Working of Ammonia Stills." P. Parrish, London, 1924, p. 44.

Now, in raising steam with the heat of coke, the expenditure on fuel—namely, 35·5d. per ton of steam—is saved, as well as some of the labour, which last, for our present purpose, we may neglect. Dry cooling of coke raises, under average conditions, 880 lbs. of steam per ton of coke cooled, which, at the same valuation, amounts to $\frac{880}{2240} \times 35{\cdot}5\text{d.} = 14\text{d.}$ The installation therefore obtains, in the form of steam, 14d. for every ton of coke cooled, and the steam from an installation cooling 500 tons per day will therefore be worth 500 tons × 350 days × 14d. = say, £10,200 per annum. At this cost, the revenue from steam will easily provide for the redemption in seven or ten years of a capital expenditure far in excess of what would be required for a dry-cooling equipment.

The site and local conditions, and the economies to be effected, will vary with every problem; and every factor which influences the question has to be examined. But to realize the figures on an assumed basis, let us suppose that we have to spend £56,000 on an installation to cool 1000 tons of coke per day, and that the initial cost is to be redeemed in seven years, by setting aside annually £8000 for that purpose,

$$\frac{£8000}{1000 \text{ tons} \times 350 \text{ days}} = \text{say, } 5{\cdot}5\text{d. per ton of coke.}$$

The installation at the gas-works of Utrecht, which was started at the end of 1926, cools 350 tons of coke per twenty-four hours. The plant supplied the gas-works with its requirements of saturated steam, and also with steam at 200 lbs. per sq. in. and 650° Fahr., to drive a 750 KW. turbo-generator. When the plant is working at full capacity, this generator is capable of feeding over one million KW. into the city mains.

Coke Screening.

By W. S. EDWARDS.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

[Extract.]

It is unfortunate that coke has to be handled, screened, and stored, for the reason that its physical character resembles that of an imaginary material having some of the leading characteristics of an egg, an emery wheel, and a sponge. The greatest care therefore is required to reduce breakage to a minimum, and the design of all machinery for coke handling must have special regard to the rapid wear which will take place in the parts with which the coke comes into contact.

The properties of coke are generally understood but not always appreciated, resulting in too niggardly a policy in regard to the extent and type of apparatus to be employed and the continued use of crude methods possessing fundamental faults which render anything like a high-class product impossible of attainment. Again, coke, owing to its structure being full of pores and cavities, allows of large pieces becoming filled with smalls and fines which do not separate out until after the large coke has found its way to the storage heap or truck, as the case may be, unless this fact is fully recognized in the choice of apparatus used.

Special Points in Lay-out.

The first thing of importance in considering the design and lay-out of a coke screening plant is to realize fully the behaviour of the coke itself throughout its passage through the plant. From the time the coke is formed in the ovens or retorts to the time it is ultimately put to use, some breakage takes place, and consequently breeze is produced every time it is moved. When the coke leaves the oven or retort, breakage occurs (this is the worst with horizontal ovens or retorts), and further breakage takes place when the coke is fed on to the system of conveyors which carry it to the screening plant.

When planning the most suitable arrangement of plant, it is essential to have a clear definition of the quality and character of the coke to be treated—namely, whether hard, fingery, soft, dry, or moist. A hard coke is very lively, and bounces at points of delivery into chutes and screens, and is very destructive of all parts with which it comes into contact. A fingery coke is troublesome in plugging up the larger screens and causing fouls in bucket elevators should a restricted lay-out render the introduction of elevators unavoidable. A soft dry coke is easier to screen but tends to make much breeze and needs the greatest care to minimize breakage. A moist coke is more difficult to separate, and tends to plug the fine screens.

The number and size of the different grades required will have to be determined. A careful analysis should be made by hand-screening to ascertain the proportion of the various sizes which may be anticipated.

Types of Screen.

The cylindrical revolving screen retains favour and is probably used more than any other, in spite of many faults and disadvantages from the standpoint of screening. It is a convenient machine from a mechanical point of view. The speed is slow, there is absence of vibration, and the screen lends itself well to a compact arrangement of storage bins.

The rotary screen will give an evenly-sized product, but it must be remembered that only a proportion of the ultimate smalls and breeze were present when the coke entered the screen; a large amount having been produced by the tumbling and grinding action of the screen itself. Furthermore, the rotary action of the screen throws the larger pieces to the bottom of the charge, thereby interfering with the passage of fine particles through their respective openings. When in operation, only about 20 p.ct. of the total area of this type of screen is active. It is not a successful screen when handling wet coke, and the maintenance and renewals of the screening medium are usually heavy.

One of the most efficient, and withal the gentlest, types of screen for coke is that known as the cataract grizzly, which consists of a nest of revolving serrated discs mounted on parallel shafts carried between fixed side frames; the discs being so interspaced with one another and so ordered in the succession of their speed as to give almost perfect screening with the absolute minimum of breakage. This machine is rapidly gaining favour as a primary screen for removing the large coke.

The jigging shaking screen is a development of the well-known colliery screen, and, while possessing the advantages of cheapness and compactness, is easily plugged up and roughly handles the coke, causing a lot of breakage and consequently smalls and breeze. The power cost is high and the maintenance comparatively heavy.

The balanced high-speed vibrating screen, of which there are a good many varieties on the market, can be designed so as to be practically free from external vibration. It has a large capacity with small power consumption, and good and effective screening in every square inch of surface, and also possesses the "kick" so necessary to work-off damp breeze from moist coke and prevent clogging and plugging of the screening medium.

Combinations of Different Types of Screen.

The various types of screens mentioned are applicable where the quantity to be handled will justify a carefully planned lay-out involving considerable capital outlay. In most modern coke plants the whole of the screening is effected by a combination of a rotary grizzly screen working in conjunction with one or more single or double deck vibratory screens. In the case of small works, where the total coke produced is in the neighbourhood of only 6 or 8 tons per hour, it is necessary to fall back on plant of cheaper and less ambitious character, and at the same time to be content with results which are a good deal inferior. For this reason, where the carbonizing plant consists of a number of small units, it is well to consider the centralization of the whole of the coke screening, cutting, and grading in one conveniently suitable central plant, which will enable advantage to be taken of the more highly developed and efficient machines which are now available, but which for the most part range in capacity from 20 to 50 tons per hour.

For quite small plants a fixed-bar grizzly, preferably of the "cascade" type with taper section bars, may be used to take out the "oversize;" the remainder being passed on to a two or three stage revolving screen. By taking out the large lumps first, the production of breeze in the revolving screen is minimized to a considerable extent.

If the coke is of a moist nature, it will probably pay to instal a double-deck vibrating screen for the smalls and fines.

Handling Coke after Screening.

After the coke leaves the screen, the problem of discharging to bins, railway wagons, lorries, or stock pile needs careful study. If the coke is dropped into deep bins, an enormous amount of breakage takes place when the bins are low or empty. Furthermore, the coke tends to segregate; the larger lumps rolling down the side of the heap, and the fines and dust forming a pocket in the middle. Spiral anti-breakage chutes are sometimes adopted, but the wear and tear on them is excessive. Inclined bins make an excellent arrangement; the coke having little or no drop, but merely sliding down the side of the bin and afterwards quietly rolling down the side of the pile.

In spite of all precautions, a certain amount of breeze will accumulate in large storage bins, so that some arrangement of bar grizzly in the delivery chutes is usual. To secure the

best results, a vibrating screen mounted on travelling wheels, so that it can be moved from outlet to outlet, can be installed on either side of the bin.

DISADVANTAGES OF OVER-RATING SCREEN CAPACITY.

A word should be said about over-rating. When selecting screens or a system of screens for the preparation of coke, it is common only to specify to the manufacturer the tonnage per hour to be dealt with, and the maximum size of the throughs, with the result that a selection is made from a number of different manufacturers, all of whom offer a machine to deal with the specified tonnage and pass smalls under a certain mesh. In a good many cases, in order to meet competition, a screen is put forward which, to handle the tonnage, is loaded far too heavily to give efficient screening.

For practical purposes, the "oversize" leaving a screen should not be found to contain more than 5 p.ct. of "undersize" when taken straight off the screen, and not after the coke has passed through the coke bin. To secure freedom from anxiety on this score, and to obtain smoother working, it is well to allow some margin over manufacturers' figures, which naturally do not err on the side of modesty. When installing new plant for preparing coke for the modern market, it pays to be liberal in design. The demand for properly-sized coke is growing more exacting every day, and higher prices are paid without demur for a first-class product.

The Utilization of Coke Oven Gas by the Gas Industry.

By T. P. RIDLEY.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

[Extract.]

The gas industry, which in magnitude is second only to the railways among public utility undertakings, has a most enviable record for trustworthiness as a public servant over a period of nearly 120 years, and to-day is more vigorous, successful, and better managed than at any other period of its long history. As evidence of successful growth and management, it may be stated that, notwithstanding all the governmental restrictions to which it is subject, and the difficulties experienced as a result of labour troubles in other industries, it has grown since pre-war days to the extent shown by the following figures, which only represent the statutory undertakings:

—	1913.	1925.
Quantity of gas sold . .	201,595 million c.ft.	265,757 million c.ft.
Increase	..	31·8 p.ct.
Number of consumers. .	6,917,747	8,200,455
Increase	..	18·5 p.ct.

Each year shows a further expansion of these figures.

Progress has also been made in manufacturing results. "Field's Analysis" for 1913 shows for 33 undertakings an average make of gas per ton of coal carbonized of 11,799 c.ft.; in 1927 the average was 14,108, an increase of 2309 c.ft. per ton—and this with an increase in saleable coke of 0·4 cwt. and 0·4 gallons of tar per ton of coal carbonized. These figures show solid and substantial progress.

On the other hand, it is admitted that, with a few admirable exceptions, the bye-product coking industry has made very little progress since 1913. The number of modern ovens erected since the armistice is very small, whereas in Germany plants are being reconstructed with ovens of the latest and most economical type at a remarkably rapid rate. The labour costs in this country per ton of coke produced are very high; the coke produced per man per day being considerably less than that of modern practice. Our plants in the majority of cases are so inefficient and expensive by comparison with those of other countries that they must eventually be rebuilt or abandoned, otherwise they will not be able to compete in the world's markets, and iron and steel makers in this country will not be able to pay the prices which uneconomic costs involve, with the result that they may be compelled to import coke. The coke oven owners say they cannot undertake the cost of reconstruction unless they can sell the greater quantity of surplus gas which will be available after reconstruction.

The majority of coke ovens in Great Britain are associated with collieries, which in the past have found it more profitable to make and sell coke and other products than to sell certain classes of coal *as coal*, and coking plants have been erected generally in small units of 200 to 300 tons per day to deal with small coal or slack produced at a particular pit. In Germany, on the other hand, they are in most cases in close proximity to large steel works where large quantities of the coke oven gas can be, and are being, utilized. Like several other industries, the coke oven industry has felt the depression in the iron and steel trade, the bad effects of the mining dispute, the decline in exports, and the fall in values of coke, tar, and sulphate of ammonia. Consequently they find it difficult to operate on a basis which provides sufficient, if any, profit. They are therefore making—and quite rightly—strenuous efforts to improve the position of their industry. They consider that one way in which this can be done is to sell to the very best advantage any surplus gas which they now have, or which by reconstruction of plant they may have, available. At present there is very little surplus gas that is not utilized in some way; but probably it is not all utilized in the most profitable manner. If, however, the coke oven owners can—as it seems certain they must—reconstruct their present plants or put down new and additional plants, there will be considerably more surplus gas to be utilized than there is at present. Additional plants, however, will be limited by the amount of coke which can be sold. The coke oven owners have come to the conclusion that the gas industry can afford to pay the best price for their surplus gas and have therefore started a campaign for the extension of the use of coke oven gas for town purposes. It is understood that they are not recommending the universal use of coke oven gas by gas undertakings throughout the country, but only where the circumstances of geographical position justify its serious consideration. They have, however, gone to the length of suggesting that in certain circumstances gas undertakings should be compelled to purchase any available surplus coke oven gas at such prices as may be fixed by a third party, in default of agreement between the gas undertakings and themselves.

In Great Britain the gas industry is considerably larger and the coke oven industry considerably smaller than in Germany, and the prices charged to the public for gas are lower generally in Great Britain than in Germany. The gas industry very naturally vehemently objects to any compulsion in the matter of taking outside supplies.

In Germany the efforts of the coke oven industry are not confined to disposing of their surplus gas to gas undertakings near to, or far from, the ovens—such is only one of the items in large schemes for utilization of bye-products. The use of surplus gas is contemplated in the synthetic production of ammonia, nitric acid, oils, and methanol, and the hydrogenation of coal. The development of scientific and economical treatment of other bye-products is also to be taken in hand. Germany has also another object in view in its long distance gas scheme, and that is to cut out the import of British coal.

It is the object, as it is the interest, of the gas industry to sell gas to the public at the lowest possible economic price. This is also in the national interest. Therefore, if coke oven gas can be supplied to the gas undertakings on terms and conditions which will enable gas to be sold to the public at lower prices than would otherwise be the case, there is no reason why the utilization of such gas by the gas industry should not extend; on the contrary, it should be welcomed. Prejudice cannot be allowed to stand in the way. On the other hand, it cannot be expected that the gas industry will purchase gas from outside itself unless the result is going to strengthen the gas industry still further in developing the sound position already attained by foresight and enterprise.

The rate of progress in the use of coke oven gas by gas undertakings has been retarded in Great Britain by reason of the fact that the coke oven owners have not sufficiently realized the difficulties of gas undertakings with regard to the statutory obligations under which they work, and which they feel they must faithfully carry out at all costs. A further cause has been that the coke oven owners in many cases have asked prices for their gas which were economically impossible for gas undertakings to pay.

CONDITIONS OF CONTRACT FOR A SUPPLY OF COKE OVEN GAS.

In giving consideration to the making of a contract for a supply of coke oven gas, the important general conditions may be summarized under three headings, as follows:

1. The supply of gas must be reliable as to the constancy of an agreed calorific value, purity, and pressure.
2. There must be freedom from failure of supply, and, if there be any doubt regarding this, means must be provided by the gas undertaking to make up any deficiency of supply from the coke ovens, in order at all costs to avoid failure in the gas undertakings' statutory obligations to the public.

3. The price must be such as, with the addition of all direct and indirect costs involved as a consequence of purchasing supplies of coke oven gas, will be less than the estimated cost of making gas at the gas-works during the period of the contract, taking into consideration the gradually increasing efficiency of gas-works plant.

In a contract for the supply of coke oven gas there must be not only a prescribed minimum number of B.Th.U. per c.ft., but also a maximum, for the reason that if the declared calorific value of the undertaking be 500 B.Th.U. per c.ft. and the gas supplied be of 550 B.Th.U., the consumer will use less volume and the undertakers will only be paid at the rate of 500 B.Th.U., or practically 10 p.ct. less than the value actually supplied. In addition, great variations cause inconvenience to consumers in the use of their appliances.

Mr. W. J. A. Butterfield, in his inaugural address to the London Section of the Society of Chemical Industry on Oct. 3, 1927[1], shows how little variation in calorific value there is in actual practice in the gas supplied by gas undertakings. Gas undertakings, in purchasing coke oven gas, limit their freedom to the calorific value which they may declare, as there is greater flexibility in this respect when manufacture is carried on at the gas-works. It may be accepted, however, that gas of a composition satisfactory to gas undertakings can be sent out from coke ovens—such is being done at Middlesbrough, Sheffield, and other places at the present time.

With regard to general condition No. 2, dealing with continuity of supply, the statutory obligation is to give, and continue to give, a supply of gas at every hour of the day and night to every owner or occupier of premises within 25 yards of a gas main who may require such a supply and to every public gas lamp within 50 yards of a main which may be required by the local authority to be supplied.

In the mining disputes of 1921 and 1926 the supplies of gas from coke ovens were either entirely discontinued or greatly reduced in practically all cases, as is shown by the figures in Appendix "A."

The possibility of failure of coke oven supplies undoubtedly does exist, and therefore it is imperative that gas undertakings should maintain stand-by plant of capacity at least sufficient to take over the whole coke oven supply, and this plant must be of such a character that it can be put into operation quickly. It may be considered to be a waste of capital, but the possibilities of labour troubles at the coke ovens, owing to their close proximity to the pits, cannot be overlooked. In some cases it is necessary to erect new plant and also to keep workmen uneconomically employed, so that they may form a nucleus gang for starting-up gas making plant at the gas works in cases of emergency. It is also necessary to maintain stocks of coal at the coke ovens or the gas-works, or both. It would appear desirable to keep large stocks of coal at the gas-works rather than at the coke ovens, because it can be conceived that circumstances connected with mines and railways may arise under which stocks of coal at the coke ovens could not be utilized. Where the coal stock is only at the gas-works, it is desirable to provide, in the contract, that the coke ovens will lay down stocks of coal if requested, so that in the event of labour troubles at mines or on the railways becoming imminent, stocks may be laid down at the ovens. This request will be made only if it is thought probable that the coke oven men will continue at work. The contract should also provide that the coke oven owners will, if required, purchase foreign coal in the event of being unable to obtain home supplies.

In Germany the question of failure to maintain supplies of gas is not considered in so serious a light as in this country. No special Acts of the Legislature exist regulating the supply of gas. The gas undertakings can make themselves exempt from liability for non-delivery or limited delivery of gas. The terms of contract of one large city are:

> The supply can at times be discontinued if and as far as it is necessary owing to disturbances in the establishment, to strikes in the undertakings, or for other reasons.

There has not been the number of failures of supply in Germany as here (in Essen there has only been one failure in 18 years), and there is less likelihood of failure, because the coke oven interests are associated and the various coking plants pump gas, purified at the ovens, into interconnected mains, and consequently gas undertakings are not dependent upon any one plant. So satisfied are they that in some cases they are content to discontinue entirely the gas-works and utilize the site for other purposes.

If the coke oven owners of this country or of the respective coking coal fields associated their interests and supplied their gas into a system of grid mains so that gas undertakings were receiving from a group of plants instead of from one plant, the risk of failure would be reduced; but this would not eliminate the labour risks to which coke ovens are subject, which risks are much greater than at gas-works, and greater also than at German coke ovens.

So long, therefore, as present legislative penalties with regard to continuity of supply to the public continue, so long must gas undertakings who take coke oven supplies continue to maintain conditions which will enable them to avoid failing the public in the event of failure on the part of the coke ovens to supply the gas undertakings. This fact, while not preventing an increased use of coke oven gas by gas undertakings, must prevent the fullest development of its utilization by reducing the economic price which gas undertakings can afford to pay for the gas, and must also create in the minds of some the thought that it is a risk too great to be undertaken.

Determination of Price.—With regard to the third condition, which is that of price, many factors must be taken into consideration; and in the past some of these have not been given the full attention they deserve. The price must be dependent upon the whole of the circumstances in each individual case.

The first question to be settled is the relation which the quantity of gas to be purchased bears to the total quantity delivered by the gas undertaking—that is, is the contract to be for (*a*) the whole requirements; (*b*) an equal daily quantity, or approximately so, throughout the year, leaving the gas undertaking to manufacture the costly peak load demands; (*c*) the peak load demands, leaving the gas undertaking to manufacture the equal daily quantity. The economic price payable will, of course, differ considerably as between the three classes of contract.

The load of a gas undertaking is very variable as between summer and winter. In an industrial area the total delivery for the year of one undertaking was 4900 million c.ft., or an average of 94 millions per week, but the demand varied from 64 million to 137 million c.ft. per week.

Not only are the weekly loads very variable, but the demands from day to day differ considerably. The lowest daily demand was 7·4 million c.ft. in summer, and the highest 20·8 in winter. The figures show variations of 4 million to 5 million c.ft. within a few days—and this is in a district where fogs are very infrequent.

Where coke ovens are supplying the total requirements of a gas undertaking, it is clear that in the summer they must utilize gas for other purposes, or waste it. In Germany the conversion of ovens to the compound type enables them to heat the ovens by producer gas made by low-grade coal or coke, by blast furnace gas, or by good coke oven gas, as circumstances may dictate. These plants therefore provide greater flexibility with regard to sales of gas and coke. In this class of contract the gas undertaking can afford to pay a higher price than if it continues to provide peak loads.

With regard to the case where the coke ovens supply a level load and the gas undertaking manufactures the peaks, the total quantity of gas which the gas undertaking can purchase is only about 50 p.ct. to 60 p.ct. of its total annual deliveries. It is obvious that the cost of making the balance must be very much higher than that of the level load or the average of the total deliveries. Consequently the gas undertaking cannot afford to pay for coke oven gas anything like its present average cost of making gas and delivering it into holders. Most of the coke oven gas sold in Great Britain is under this class of contract, whereas in Germany the total requirement contract is the greater sale.

In the case of the gas-works manufacturing a level load, and the coke ovens supplying the peaks, the position is reversed, and the gas undertaking will, of course, be in a position to pay a higher price. This class of contract has been introduced in Germany, but I am not aware of any such contract existing or contemplated in Great Britain at present.

Sliding-Scale.—All contracts should provide for increases and decreases in price in relation to general cost of manufacture; and for this purpose a sliding-scale based on the price of coal is probably the most satisfactory to both parties. For this purpose it is necessary to fix a standard price of coal.

Charge to be Borne by Gas Undertaking.—A gas undertaking considering the question of a contract for a supply of coke oven gas, and having settled the type of contract and the quantity of gas to be purchased, will find it desirable to make up two statements of total money costs. The greater the detail in which these two statements are made up, the greater will be the accuracy attained in ascertaining the costs which continue, or partially continue, and those which entirely cease, if coke oven gas be purchased.

Statement "A" should show the cost of gas into holder if gas be continued to be manufactured at the gas-works with coal *at the standard price* and statement "B" should show the cost of gas still to be manufactured at the gas-works with coal at standard price and taking into account how each item of cost will be affected by the reduction in quantity manufactured, and with adjustments for the following items of such of them as may be involved:

> *Purification* if gas not supplied purified. The gas-works having purifying plant, capital expenditure is saved if such plant is utilized.
>
> *Alterations at works* for sectionalizing plant necessitated by the purchase of outside gas.
>
> *Repairs to existing* plant put out of action, so that such may be in a condition to be utilized as stand-by plant.

[1] "GAS JOURNAL," Feb. 14, 1928, Carbonization Conference Number.

Maintaining stand-by plant in condition of readiness.

Allowances to employees displaced, if such allowances are not to be paid out of existing pension scheme funds.

Nucleus gang for starting up stand-by plant, if not economically employed meantime.

Extra stock of coal, coke, and oil for carburetted water gas plant, *plus* additional handling, if any.

Standing charges, which are increased per ton of tar distilled, if the undertaking distils its tar.

Carburetted water gas. It may be necessary to use a larger quantity of oil owing to the calorific value of the coke oven gas being lower than the coal gas displaced at the gas-works.

New plant required to be provided as stand-by plant, or for any other reason due to the purchase of outside gas—*i.e.*, increased gasholder capacity, measuring or purifying plant.

Sinking Fund to provide at expiration of contract a sufficient sum to construct or reconstruct plant necessary to take up manufacture of gas represented by the contract quantity.

Reconstruction of plant which may be saved if such is not wholly provided for in repairs and maintenance of works in Statement "A."

State Insurance, Workmen's Compensation, Profit Sharing, and *Superannuation* contributions which may be saved.

Margin required by gas undertaking to cover improved future efficiency of gas-works manufacture, including the results of the possible introduction at gas-works of synthetic processes, and from which they will be debarred, also to cover loss of freedom with regard to the most economical declarations of calorific value of gas which they may supply, and for other risks.

The balance between the statements "A" and "B" will be the sum which, divided into the quantity of gas to be taken, will be the price per 1000 c.ft., or per therm, which the gas undertaking can afford to pay for the gas proposed to be purchased. The price thus ascertained is on the assumption that the gas is delivered through mains laid and maintained (including way-leave rents) at the cost of the coke oven gas suppliers, and that the gas is paid for on measurement at the gas-works. Otherwise interest and redemption of the cost of the mains over the period of the contract, way-leaves, maintenance, and loss in transit of gas must be taken into account and consequently a reduced price be payable by the buyer. It appears desirable that the sellers should supply the commodity delivered at the gas-works, as there is a risk that the sellers may be unable to continue in business, in which case the gas undertaking would be saddled with a loss of capital. There is no risk of the gas undertaking being unable to continue in business. In the new long-distance scheme in Germany, the gas undertakings are not called upon to provide capital for mains.

From the foregoing it is obvious that a flat economic price payable by all gas undertakings, even in the same neighbourhood, is impossible; and therefore every sale must be decided on the circumstances of the individual case. The economic price in respect of a certain quantity of gas for an undertaking may differ from that for a further quantity for the same undertaking, inasmuch as the first quantity may displace gas manufactured under expensive conditions, whereas the further supply may displace gas manufactured much more cheaply. Each case presents different factors demanding careful commercial and technical judgment.

Coke oven owners must, of course, take into account all costs, direct and indirect, which they will be called upon to incur, and weigh up whether it will pay them better to supply gas to the gas industry or utilize the gas in other ways.

With regard to transmission costs, Mr. Stephen Lacey, in his paper before The Institution of Gas Engineers in June, 1928, gave some interesting figures, as did also Dr. E. W. Smith, in his paper read before the Midland Section of the Coke Oven Managers' Association in January, 1927.

Extent to which Coke Oven Gas can be Absorbed by the Gas Industry.

The numbers of gas undertakings in 1926 were 784 statutory and 597 non-statutory. As the latter represent a sale of only 7500 million c.ft. out of a total of 284,000 millions, and are generally in isolated places, they may be ignored from the point of view of providing the possibility of any material extension of the utilization of coke oven gas.

Here is a map showing the location of coke ovens in Great Britain and the area within 50 miles radius of any coke ovens. It shows that South Scotland, North and Middle England, and all Wales are covered, and that the Eastern Counties, London, and most of the Southern Counties are outside the radius. The principal places of gas consumption uncovered have cheap water transport and markets for coke at good prices, whereas coke oven gas would be hampered by long transmission costs.

There are not any published records of the quantities of coke oven gas available for purposes other than the heating of ovens. An attempt has been made to give an estimate (see Appendix "B") of the quantity of gas available based on 1000 c.ft. from waste heat and 6000 c.ft. from regenerative ovens per ton of coal carbonized, and on the coal carbonized in bye-product ovens in 1925 in the districts given in the annual report of the Secretary for Mines. This will provide an indication of the possible quantities of coke oven gas which might be available in the various districts. Against these figures is shown a year's sale of gas by gas undertakings, and the quantities of coke oven gas purchased by gas undertakings in the various districts. From this an idea can be formed of whether the whole of the gas at present produced, and not used for oven heating, could be utilized by the gas industry within the 50 miles radius; but it must not be forgotten that the figures of available coke oven gas shown in Appendix "B" are on the assumption that surplus gas is not utilized for any other purpose than the supply to gas undertakings. This, of course, is not the case in practice. As stated previously, there is very little gas wasted, but that which is now used may not all be utilized as profitably as if it were sold to a gas undertaking. An approximation can also be arrived at of the quantity of surplus gas if the same quantity of coal be carbonized in the latest type of ovens.

If all the coal at present carbonized in waste-heat and in regenerative coke ovens was carbonized in compound ovens, there

Map of Great Britain, showing Bye-Product Coke Ovens.

Black area shows 50 miles radius from coke ovens.

would not be nearly sufficient surplus gas produced to meet the total town gas sales of Great Britain. To extend the carbonization of coal at coke ovens to produce sufficient gas to meet such sales would produce more coke than is at present sold by coke ovens and gas-works combined—and there is already a world over-production of coke.

Direct Supply of Coke Oven Gas for Industrial Use.

With regard to the suggestion which has been made in some quarters that coke ovens should supply gas direct to large industrial users, it must be remembered that for many years, and particularly in recent years, gas undertakings have been cultivating the industrial use of gas, and special departments have been set up in the large undertakings to deal with such. In Birmingham the proportion of gas sold for industrial purposes has been increased from 5 p.ct. of the total sales in 1911 to 30 p.ct. in 1927. In Sheffield the sales of gas for industrial purposes represent 45 p.ct. of the total sales. The gas industry has

done a great deal of propaganda work, and accomplished much to improve gas apparatus for manufacturing purposes, in each district designing plant to suit the particular trades of the district. Much has been achieved notwithstanding the severe restrictions under which the gas undertakings have worked with regard to prices and dividends. The industry has asked the Government to give it greater freedom with regard to charges; and if this be obtained, the gas industry will be in a very much better position than hitherto to compete for industrial business having good loads and requiring large quantities. In Germany the coke oven owners are prepared to supply gas for industrial uses within gas undertakings' areas through the gas undertakings themselves, and to sell such gas at lower prices if the gas undertakings pass on to the industrial consumer a large proportion of the price advantage.

With regard to the sale of unpurified gas, after taking into account the low cost of purification and the cost of special mains and storage which would be necessary, it does not appear to be worth while in this country to develop the sale of unpurified gas as against purified gas. Many town gas undertakings have had powers for years to supply crude gas, but in no case has it been found worth while to exercise the power.

The solution of cheap gas for industrial purposes is not in the sale of unpurified gas, but in the sale of purified gas, using the distributing systems with which the gas undertakings are already equipped, and by the gas undertakings obtaining the power they are seeking to sell gas for industrial and other purposes on terms which bear a more correct relationship to the cost of giving such supplies than at present operates, and under which the large consumer bears an undue proportion of fixed costs.

SALE OF COKE.

The question of supplies of coke oven gas to the gas industry is closely bound up with the question of the sale of coke. The primary object of the coke oven industry was originally the production at the lowest possible cost of hard coke suitable for the iron and steel industries. The coke oven owners are however, now doing their utmost to secure the markets long held by the gas-works for softer coke, because they are markets in which higher prices are generally obtained. If gas undertakings should find difficulty in disposing of their coke of present type, they will so adjust their methods of manufacture as will enable them to produce whatever coke meets the public demand, even to the extent of erecting modern coke ovens in the gas-works, which can be worked to meet summer and winter demands in a much more flexible manner than the present regenerative ovens. If necessary, more amalgamations and association of interests of gas undertakings will take place. In these ways the gas undertakings would widen their market for coke by being in the position to supply both soft and hard coke. Gas undertakings are in the advantageous position that they are usually surrounded by a domestic market, with consequent low transport costs on coke, whereas in most cases the coke ovens are not so well placed in this respect. Such a development might result in restricting the quantities of coke oven gas which the gas undertakings might purchase from outside.

FUTURE DEVELOPMENTS.

The quantity of coke oven gas purchased by the gas industry from coke ovens has been gradually increasing during the last few years, as is shown by Appendix "A." The year 1929 will show a greater increase than in any previous year owing to new contracts recently made coming into operation. The quantity which coke ovens will then be supplying will practically equal the quantity at present being sold to gas undertakings by coke ovens in the Ruhr. A larger development is in progress in Germany, but, as has already been indicated, there are many differences in conditions between Germany and Great Britain which make the development of the utilization of coke oven gas by the gas industry here more difficult.

It is very desirable, however, that there should be understanding and co-operation between the coke oven and the gas industries and there is more of this to-day than at any period in the history of the two industries. They are working hand in hand in the disposal of sulphate of ammonia, benzole, pitch, creosote, and road tar; and there is no reason why there should not be closer co-operation with regard to gas and coke. It is this greater understanding which has resulted in the recent large contracts for coke oven gas. With still greater mutual understanding, there will be further progress. The recent setting up by the two industries of a Joint Standing Committee to consider the problems affecting the supplies of gas and coke will greatly assist in this direction. Information is given in this paper which it is hoped may be of assistance to both industries. It should be understood clearly that the gas industry is not against the use of coke oven gas—what it is against is the utilization of it at uneconomic prices, and it is also against any question of compulsion.

Coke oven gas cannot be sold to other industries on terms which are not economic to those industries. The gas, being a bye-product of coal production, can only be utilized on terms which are economic to the user, whoever he may be.

It is in the national interest that every effort should be made to secure the most economic use of coke oven gas. This in some cases may be found to be in steel works—particularly if modernized ovens be erected adjacent to steel works, as has been put forward frequently, and was particularly recommended at a recent meeting of the Institution of Civil Engineers by Prof. Bone, of London, and Prof. Louis, of Newcastle. In other cases it may be found in synthetic processes and in others in sales to public utility undertakings.

It is the author's opinion that there will be a growth in the quantities of coke oven gas utilized by the gas industry, particularly in the coke oven districts, but it must not be overlooked that there are many gas-works equipped with modern plant specially designed for the production of gas at the lowest cost, where the economic price which can be paid for an outside supply, after adjustment for the items enumerated above, is such as may not be so attractive to coke oven owners as the utilization of their gas in other ways.

It does not seem advisable in the national interest that there should be any sudden grandiose schemes for the general utilization of coke oven gas in any particular direction. It is better that it should be developed gradually on economic lines.

APPENDIX A.—*Amount of Coke Oven Gas Bought by Gas Undertakings.*

[Figures in Thousands of Cubic Feet.]

Purchasing Undertaking.	1920.	1921.	1922.	1923.	1924.	1925.	1926.	1927.
Chesterfield Corporation	17,632	9,345	35,790	50,025	134,609	133,049	101,794	121,737
Dinnington and District Gas Co.	..	2,491	32,452	35,834	40,510	42,545	29,170	52,121
Leeds Corporation	104,022	97,869	243,192	227,872	318,057	401,668	118,587	298,765
Little Hulton U.D.C.	24,410	3,859	21,751	20,520	19,550	19,551	10,080	21,394
Middlesbrough Corporation	656,803	392,830	686,389	853,554	892,848	916,640	380,866	1,046,811
Ossett Corporation	..	29,716	151,112	164,203	164,724	158,853	82,376	147,207
Port Talbot Corporation (Margam Undertaking)	..	17,282	62,682	79,141	68,533	92,380	36,484	85,050
Rhymney and Aber Valleys Gas and Water Co.	..	242,421	289,249	268,331	278,637	293,661	274,564	283,720
Rotherham Corporation	74,270	67,404	202,592	239,707	237,174	240,710	138,623	365,236
Sheffield Gas Company	505,799	328,072	1,548,764	1,903,433	1,819,360	1,849,299	689,495	1,856,560
Stockbridge Gas Company	..	30,049	30,542	38,378	41,719	47,299	31,261	35,821
Swinton and Mexborough Gas Board	64,414	41,744	67,539	70,881	75,661	77,763	29,557	70,769
Wath, Bolton, and Thurnscoe Gas Board	89,575	61,725	114,386	116,850	127,880	132,892	51,549	106,709
Eckington and Mosboro' Gas Co.	..	..	643	16,948	38,000	38,000	26,204	37,000
Kidsgrove Gas Light Co.	..	..	15,758	45,543	51,076	54,308	22,424	49,791
Pontypridd U.D.C.	..	..	132,837	136,835	138,885	145,133	72,079	145,507
Staveley Gas Light and Coke Co., Ltd.	..	..	..	..	12,691	17,429	14,196	12,405
Wombwell U.D.C.	..	..	..	..	11,000	86,000	31,806	78,014
Castleford and Whitwood Gas Light and Coke Co.	..	..	..	..	..	22,000	62,230	145,000
Houghton-le-Spring District Gas Co.	..	..	..	..	..	21,433	20,698	48,815
Manchester Corporation	..	..	..	..	..	7,139	1,226	..
Glasgow Corporation	..	..	..	..	..	..	96,671	210,817
Rawmarsh U.D.C.	..	..	..	..	..	..	..	73,155
Redcar Corporation	..	..	..	..	..	..	..	27,682
Worsbrough Dale and Worsbrough Gas Light and Coke Co.	..	..	..	..	..	..	..	18,037
Total	1,536,925	1,324,807	3,635,678	4,268,055	4,470,914	4,797,752	2,321,850	5,340,223

APPENDIX B.—*Surplus Gas at Coke Ovens and Sales of Gas by Gas Undertakings.*

[Figures in Thousands of Cubic Feet.]

Group.	Estimated Quantities of Coke Oven Gas Not Used for Heating of Ovens.		Sales of Gas by Gas Undertakings.		Coke Oven Gas Purchased by Gas Undertakings.
North Western—					
Cumberland	3,977,982		1,029,972		
Westmorland	..		156,139		
		3,977,982		1,186,111	
North Eastern—					
Durham	9,413,267		4,381,327		48,815
Northumberland	..		5,234,165		
North Yorkshire	6,226,341		2,412,401		1,074,793
		15,639,608		12,027,893	
East Midland—					
South Yorkshire	14,632,959		23,151,831		3,300,162
Lincolnshire	2,686,412		1,987,495		
Derbyshire	1,753,562		3,541,165		49,405
Notts	97,261		3,565,941		
Leicestershire	..		3,719,519		
Rutland	..		27,684		
Northampton	..		2,129,746		
		19,170,194		38,123,381	
Lancashire, &c.—					
Lancashire	2,604,981		35,007,827		92,163
Cheshire	42,147		5,651,198		
North Wales	94,019		1,011,347		
		2,741,147		41,670,372	
West Midland—					
Staffordshire	3,024,825		10,086,309		49,791
Shropshire	76,188		604,638		
Warwickshire	641,922		16,431,433		
Worcestershire	..		2,141,867		
		3,742,935		29,264,247	
South Wales—					
Glamorgan	4,705,826		4,297,049		514,277
Monmouth	3,446,291		934,413		
Cardigan	..		87,431		
Hereford	..		247,344		
Radnor	..		14,861		
Brecknock	..		82,700		
Carmarthen	..		167,400		
		8,152,117		5,831,198	
Scotland—					
Lanark	1,077,978		10,612,159		210,817
Stirling	282,057		624,014		
Midlothian	..		2,815,849		
Renfrew	..		1,455,427		
Other Counties	..		2,175,374		
		1,360,035		17,682,823	
		54,784,018		145,786,025	5,340,223
Areas outside of 50 miles radius of present coke ovens.					
In England and Wales—					
(*a*) London and Suburbs	..		80,120,272		
(*b*) Other places	..		46,742,478		
In Scotland	..		3,919,872		
				130,782,622	
Grand total		54,784,018		276,568,647	

The Gas Industry as a Source of Domestic and Industrial Energy.

By F. W. GOODENOUGH, C.B.E.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

The old truism, "Money saved is money earned," may well be adapted for the purpose of this Fuel Conference (and especially for that of a paper on "Gas as a Source of Energy") to read "Energy saved is energy created."

The particular and outstanding services which the gas industry renders to modern civilization are: (1) That of making available from every ton of coal treated a higher percentage of its potential heat value than is secured by any other method of dealing with it which eliminates the smoke and dirt attending its direct combustion; (2) that of reducing to a minimum the expenditure of human energy required for the conduct of operations necessitating the use of heat.

The Gas Industry is Thermally Efficient.

When the potential heat of coal is converted into electrical energy through the medium of steam engine or turbine, its use in that way to produce heat or power requires the employment of a large amount of human energy on dirty and exhaustive work. The proportion of the potential heat made available to the consumer only reaches 20 p.ct. (say, 58 therms per ton) in a very few cases; the average is substantially below that figure.

When coal is carbonized at a modern gas-works, 25 p.ct. of its potential heat value—say, 72 to 73 therms out of a total of 290 therms per ton of coal—is obtained in the form of gaseous fuel, while half the total heat value (say 145 therms) is returned to the fuel market in the shape of coke and breeze. If that coke be then used to raise steam in a modern electric generating station, energy representing 25 to 30 therms will be rendered available to the community. There is, further, to be taken into account the highly valuable chemical bye-products that are obtained from the carbonization of coal and the subsequent distillation of the resultant tar and the treatment of the ammoniacal and cyanogen liquor residuals, which, measured in terms of calorific value, represent about 15 therms per ton of coal. (If measured in terms of value to industries of many and varied kinds* or of food productivity, in times of peace, or in terms of national defence in times of war, these chemical bye-products of the gas-works will be found to have an economic value far in excess of their calorific value.)

It is therefore seen that an undertaking which carbonized coal and then converted the residual coke into electrical energy could sell, as gas, as chemical bye-products, or as electricity, from 112 to 118 (say, 115) therms per ton of coal; whereas, if the same coal went to an electric generating station to be burned

* The subject of "The Use of Town Gas in Industry" was dealt with exhaustively by Sir Arthur Duckham, K.C.B., in a paper presented to the World Power Conference in 1924, and it is unnecessary to repeat here all the facts therein set out. It is sufficient to state that in the past four years the use of gas as a fuel in industrial processes has rapidly increased. In the district of the largest gas undertaking, that of the Gas Light and Coke Company—a district mainly residential and commercial—the sale of gas for industrial purposes already represents 11 p.ct. of the total, and is growing rapidly. In Sheffield it has reached 45 p.ct.; in Coventry 40 p.ct.; in Smethwick 39 p.ct.; in Redditch 35 p.ct.; and similarly in every industrial centre in the country it has reached substantial dimensions and is growing rapidly year by year. A smokeless Britain is to-day no idealist's idle dream, but the practical man's hope and expectation.

under the boilers, the best output of energy to be hoped for would be one-half that figure.

COAL CONSERVATION.

From the point of view of coal conservation (the conservation of our great national source of energy) the gas industry as a source of energy, therefore, stands easily first, and should receive every possible consideration and encouragement from those whose business it is to study the nation's economic interests fom all standpoints—that is, from the Government of the day, whatever its political colour may be, and from the Government departments particularly and permanently concerned.

The same conclusion will be reached from another line of consideration. In the year 1927 (the year ended March 31, 1928, is taken where municipal undertakings are concerned) about 19 million tons of coal were, it is estimated, carbonized in the gas-works of the British Isles; and 1500 million therms of gas were supplied to some 9,250,000 consumers. Of this quantity, the writer estimates that 1000 million therms were used as domestic and general fuel and 125 million therms as industrial fuel.*

At the time of fuel rationing during the war, it was found that from 50 to 75 therms of gas—say, about 60 therms on the average—would do the useful work for the domestic consumer previously done by a ton of coal; and that 50 therms was on the average sufficient to produce the same output for the manufacturer as a ton of coal used for industrial heating. (These figures were, and are, bound to be only approximate, as the actual equivalents necessarily varied and would vary with the processes requiring the use of heat and with the plant employed and the conditions of working.)

Taking 70 therms per ton of coal as the average result obtained at the gas-works, it will be seen that, to do the equivalent work in domestic and industrial heating for which 1125 million therms of gas were required in 1927, a consumption of raw coal of over 19 million tons would have been required,

$$\frac{1000}{60} + \frac{125}{50} = 19{,}160{,}000$$

as against $\frac{1125}{70}$ = 16 million tons carbonized; and whereas, on the one hand, from the 19 million tons so required to be burned raw no residuals, in the form either of solid fuel or of chemical products, would have been recovered; on the other hand, from the 16 million tons carbonized, 8 million tons of coke, as well as large quantities of chemical bye-products, were obtained for sale. The net conservation of coal resulting from carbonization in place of combustion was, therefore, over 11 million tons for the year.

OTHER ADVANTAGES.

There is yet a further conservation of energy resultant from carbonization in lieu of combustion to be taken into account; though here, as in the enormous conservation of human energy in home and factory, it is impossible to assess and state the conservation in pounds, shillings, and pence, or in horse-power-hours (or woman-power-hours). The further conservation referred to is that of property; of time; of human life; of health; and of the energy derived, both physiologically and psychologically, from cheerful as contrasted with gloomy surroundings—from "a place in the sun" instead of a place in the gloom, made possible by the progressive diminution of the smoke pall over our towns and cities, and the consequent increase in the hours of light and sunshine.

No statistics are available or evidence on record as to the saving of human energy effected by the substitution of gas for the use of nearly 17 million tons of coal in the homes of the people of this country, or of 2,500,000 tons in our workshops and factories; but it is probably a conservative estimate to say that, on the average, one-third of the work of one domestic servant is saved per household in which gas is employed as fuel—in many cases the number of servants has been reduced by one, in some by as many as two. On this basis, it may be calculated that the work of 3 million domestic servants is regularly saved by the use of gas instead of raw coal. The writer regards this as an under-statement of the facts. For the saving of stokers' time in workshops and factories due to the use of gaseous fuels no basis of calculation is available; but the handling of 2,500,000 tons of coal per annum (say, 1000 tons per working hour) and the resultant ash, and the tending of the fires in which that quantity would be burned if gas were not used, would obviously entail the employment of a large number of men, rendered unnecessary by the use of gas.

Viewed from every standpoint, the gas industry, by its constant development of efficient appliances for providing fuel for every kind of domestic and industrial process requiring heat—including, at its latest development the use of heat to promote refrigeration—is both a great agent for the conservation of energy and a highly efficient source of energy, alike in the home and in the factory; and all the evidence proves that it is being recognized and utilized as such in growing measure every year. That evidence may be crystallized in the figures published by the Board of Trade for the make of gas by statutory undertakings in England, Wales, and Scotland, in the past quarter of a century:

Year.	Million C.Ft.
1903	159,864
1913	219,105
1923	259,850
1927	297,697

FUTURE PROGRESS.

The remarkable development which these figures indicate has taken place despite the antiquated legislation which governs the gas industry in Great Britain. Seeing that England was the birthplace of public gas supply, it is perhaps not surprising that much of the legislation controlling it dates back eighty years; but if the householder and industry generally are to secure in full measure the benefits resulting from the widespread use of gas, it is essential that the industry should be freed from the cumbersome and useless shackles which restrict its full development, and that the control of this great public service should be based on modern needs and modern conditions. For instance, gas undertakings should be enabled, as they are in other countries and as are other public utilities in England, to offer such scales of charge as will enable both domestic and industrial users to avail themselves to the utmost of the advantages which a gas supply provides. Furthermore, every facility should be given gas undertakings to co-operate one with another, and with allied and ancillary industries, for the more economic production and supply of gas. In the matter of gas legislation, England lags behind probably every other nation.

* Sir A. Duckham, *loc. cit.*

The Bye-Product Coke Oven as a Source of Industrial and Domestic Energy.

By C. P. FINN and R. RAY.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

The exploitation of the various sources of energy available to man extends and progresses as his requirements—industrial and domestic—expand. That which sufficed for one generation is inadequate for the next, and the luxury of to-day becomes the necessity of ten years hence. The bye-product coking industry owes its progress to some of these phases, arising primarily out of man's need for increasing quantities of iron and steel for his peaceful needs, and, sad to say, was also stimulated largely by his requirements in instruments of offence and defence.

Charcoal, the first reducing agent used in the production of iron, was superseded by the carbonaceous residue obtained in a similar manner by the use of coal instead of wood. Ideas as to the better utilization of the energy made available by the carbonization of coal bore fruit, developments in heating systems, such as the introduction of the principle of regeneration, came about, and uses were found for bye-products in the expanding chemical industry, so that encouragement was given to the study of the bye-product coking process. In turn this led to the production of suitable constructional materials, increase in size of plant, and the introduction of labour-saving machinery. Associated also with this progress were the cleaning of small coal and the utilization of what, in many instances, had been considered hitherto as waste, or as of too low a grade to be employed in the manufacture of coke.

In more recent times, much study has been given to the question of heat economy with a view to increasing the amount of available gas. With this object in view, in addition to improvements in design of flues, &c., ovens have been constructed so as to be heated by poorer gases, such as blast furnace or producer gas, thus liberating a greater part, or the whole, of the richer coal gas.

The obtaining of a true heat balance of the process has been, up to now, a difficult task, and is regarded by some authorities as impracticable. Suffice it to say that, of the heat transmitted to the oven—using coal of 30 p.ct. volatile matter and contain-

ing 3 to 4 p.c. of moisture—67 p.c. is utilized in carbonization of the charge, being discharged in the hot coke, gases, and water, &c., vapours, radiation, or other losses; while the last-mentioned item, together with chimney loss, makes up the remaining 33 p.c.* Although, owing to the intermittent nature of the coking process, it is impossible to reduce completely to zero these losses, much attention has been, and is being, devoted to the problem of heat conservation by the introduction of insulating materials and the speeding-up of charging and discharging operations. In view of the claims made by some constructors, it is very desirable that heat measurements be undertaken on modern plants by independent and competent investigators recording all the factors pertaining to the test; but we make the suggestion with diffidence, knowing full well the difficulty of inducing firms to agree to such a trial.

Energy Available from the Bye-Product Coke Oven.

In considering this we have refrained from treating the matter from any but a very general point of view, as any statistical figures necessarily would apply only to the particular coal under discussion and would be comparable only when carbonizing and recovery conditions were identical. The industrial uses of the resultant products of coking—solid, gaseous, and liquid—are by far the most important, and will be dealt with in that order.

Coke.—As a source of industrial energy, coke is one of the most important and valuable fuels. It is primarily manufactured in the coke oven for utilization as a reducing agent in the blast furnace, and, as such, plays a vital part in the economics of the heavy industries as the source of blast furnace gas. In ideal circumstances blast furnaces are to be found working alongside coke ovens on the one hand, and iron and steel works on the other. Such a self-contained works has everything in its favour from the point of view of the complete utilization of the energy lying latent both in the coal and in the coke; for, in the first instance, the coke oven gas produced during carbonization can be used in the steel works soaking pits, &c., while the blast furnace gas is absorbed in heating the coke oven flues or in the production of electrical power by the medium of gas engines or boilers and turbo-generators.

The importance of heating coke ovens by blast furnace or other low calorific value gas has just begun to be realized in this country, though since the war a considerable number of installations designed for this purpose have been erected on the Continent. Several are, however, now under construction or projected in Great Britain, and if purchasers were satisfied regarding the cost and efficiency of dust-extraction plants, progress, where conditions are favourable, would be rapid.

The utilization of blast furnace gas for power production by means of gas engines is now common practice; the power, in its turn, being used in driving machinery in the adjacent engineering shops. The largest gas engines in the world (7000 H.P. each) are to be found at a well-known works in Derbyshire, while at many other centres gas engines are running regularly and satisfactorily on this gas as a fuel.

In many other ways coke plays an important part in the production of energy in industry. Thus, much steam for general use, and also for the driving of turbo-generators for electrical power production, is generated from small coke breeze and dust, either charged alone or mixed with coal slurry to a specially constructed boiler furnace. This, in many cases, is the only way of disposing of such low-value products of the coke oven, and is a cheap method of steam and electricity production for consumption on or near the producing plant.

The firing of specially designed boilers with pulverized coke breeze and dust of a suitable quality is a development of which more will be heard in the near future.

The carbide, cyanamide, and carborundum industries—to mention only a few—depend upon the latent energy stored up in coke, while vast quantities are absorbed in the production of blue water gas. Producer gas, as a rule, is generated from coal, but within recent years the utilization of coke and coke dust in this connection has made rapid progress, until now producer gas is of special interest to the managers of modern coking plants, fortunately situated geographically for the disposal of their high-value calorific coke oven gas, in so far as they can, by the utilization of their small breeze and dust in this manner, generate producer gas for heating their ovens, and so liberate the whole of the coke oven gas for industrial or domestic purposes. In this connection it is quite possible that, in the near future, a large additional production of coke breeze and dust may result from the breaking of coke for domestic use, the only economic method of disposal of which is by means of some suggestion such as is offered above.

Coke Oven Gas.—This is a source of energy in industry, the value of which, in this country at any rate, has not yet been fully appreciated. In Great Britain it is the exception rather than the rule to find coke oven plants situated in close proximity to the iron and steel works, which could, of course, absorb the whole of the gas produced. As this does not obtain, however, in the great majority of cases, the facts must be looked at in the face, and another outlet found for the valuable gaseous products of the coke ovens. For years, even before the first rumours of the great Continental coke-oven gas distribution schemes reached us, a few small voices on both coke oven and gas-works platforms were endeavouring to preach the gospel of national thrift in gas. Their labours are only just beginning to bear fruit. The value of coke oven gas for domestic purposes *via* the gas-works has been recognized by a number of centres, and the leaven is spreading rapidly. It is in industry, however, that the producer of coke oven gas sees his market in the future, and it is towards that goal that he is working hand in hand, if possible, with his colleagues in the gas industry. Cheap, clean, and easily controlled gas is only on the threshold of its development as an industrial necessity. Town gas, at the moment, even at its cheapest, is too dear for many industries; but granted the relaxation of certain Home Office regulations, and whole-hearted co-operation between the producers of town gas and coke oven gas, a vast supply of crude oven gas could be placed at the disposal of manufacturers at a figure which would be profitable to all concerned, while a great national asset would be brought into being.

It is true that to-day there may not be a vast quantity of coke oven gas available, but many modern coking plants are either under construction or projected, so that the gas produced will be augmented in the near future.

In the past coke oven gas has, in many instances, been blown away into the atmosphere or has been wastefully used under boilers. Certain firms have successfully transformed it into electrical power by means of gas engines or *via* boilers and turbo-generators. Astonishing figures, which can, however, be vouched for, have been produced in connection with the former operation, which finally disposes of the suggestion that good results are impossible in gas engines with such a high calorific gas.

Two instances of the cost of production of electricity by means of gas-engine driven generators are given:

Actual Working Costs of Production of Electricity from Surplus Coke Oven Gas.

Type of gas engine	4-Cyl. Tandem (National).	Straight 6-Cyl. (National).
Age	10 Years.	2 Years.
Horse-power	450	600
Total B.O.T. units generated	1,362,430	4,089,940
Direct and maintenance wages	0·072	0·020
Maintenance stores, including water, oil, waste, wipers, emery cloth, sundries, &c.	0·041	0·025
Repairs (outside invoices)	0·051	0·0015
Depreciation of engine, 7½ p.ct.	0·051	0·029
Purifiers, 50 p.ct. wages and oxide of iron	0·005	0·0015
Cost of gas at 3½d. per 1000 c.ft.	0·105 (*a*)	0·087 (*b*)
Depreciation on gasholder	0·007	0·002
Total cost per B.O.T. unit.	0·332	0·166

(*a*) 30 c.ft. of gas per B.O.T. unit. (*b*) 25 c.ft. of gas per B.O.T. unit.

So far, in this country, coke oven gas has not been utilized in connection with the various processes for synthetic ammonia production, &c.; but with the period of coke oven reconstruction just commencing, it will be surprising if within the next few years some such developments do not occur.

Tar.—Tar in Great Britain is considered too valuable a substance to be used as a fuel in the raw state. As such it has been extensively applied, particularly in America. Its liquid distillation products in the form of creosote and heavy oils were of welcome use as naval fuel oils during the war. Pitch, too, finds a useful, if an apparently diminishing, outlet in the manufacture of patent fuel and briquettes, and also in the electro-chemical industries.

Benzole.—Benzole, in the rectified form, is probably the best motor fuel on the market for the existing types of motor car engine, and it is worthy of note that the first east to west Atlantic flight was accomplished on this fuel.

Ammonia.—Ammonia as a fertilizer and source of plant nitrogen takes its place in the list of valuable sources of energy to be obtained from the bye-product coke oven. It played a noteworthy part, together with derivatives of benzene and toluene, in the supply of the high explosives necessary for the late war, and these compounds naturally have their many peace-time uses. The use of ammonia as a refrigerant is another application. The bye-product coking industry now feels the competition of synthetic ammonia, but, in that it renders possible the production of hydrogen either by the coke—water gas method, or from coke oven gas, the industry will perform a useful rôle. Cheap hydrogen and carbon monoxide will, in years to come, become very important raw materials in the conversion of solid coal and coke into liquid fuels.

Energy for Domestic Purposes.

As we have seen, the bye-product coking industry was developed primarily in connection with the iron and steel industry, and the use of its products for domestic purposes is another evolutionary stage. The development of central heating, particularly on the Continent of Europe and in the United States, drew attention to the possibilities of *graded* coke oven coke as suitable fuel for that purpose. In these islands evolution has been slower, yet there is an increasing demand for cut and

* Porter—"Coal Carbonization."

sized coke oven coke in the larger cities, influenced by the uniformity of quality as regards ash and moisture due to the methods used in coal preparation and coke production. Arising out of this it has been found practicable to burn certain types of coke oven coke in ordinary grates, and more successfully so in specially designed grates. This has drawn the attention of the coking industry to the production of a specially suitable domestic fuel. Many competent students of the problem believe that, in the carbonization of coal to produce suitable domestic fuel, the high-temperature coke oven worked under suitable conditions, and supplied with a suitable coal or blend of coals, will yet play a very important, if not the most important, part in attaining the ideal of a smokeless land; for in addition to the solid product, the gaseous and liquid products are materials of known commercial value.

That there is a trend in this direction is seen in the United States, where the modern bye-product oven is built with a view to the production of domestic solid and gaseous fuel, and on the Continent, where the distribution of coke oven gas for town purposes over long distances is an accomplished fact.

TREND OF DEVELOPMENT.

References have been made in preceding paragraphs to the many apparent signs in this country of the commencement of a period of reconstruction in the coking industry. This is not without significance, for it demonstrates the fact that the more progressive of our industrialists realize that the industry has not kept abreast of the times, but was in danger of falling into a state of decay which would inevitably affect adversely the whole industrial fabric of the country.

With its rehabilitation, however, the whole picture of the future changes; and already developments which a few years ago dared not even be dreamt of are taking shape. Such developments have unquestionably been influenced by the great Continental schemes in Germany, Belgium, and Holland, for the perfection of the distribution of coke oven gas for domestic and industrial purposes. The utilization of gas per person in these islands far exceeds that of the countries mentioned, but we would not say that it has reached the highest level. It may not be possible, nor indeed advisable, to carry out a gas grid scheme of the same nature as (say) the German one, but, undoubtedly, some modified or localized development of the same or a similar type will have to come about. Industry wants cheap energy in the form of gas; and when one considers how much could be saved nationally by eliminating the transport of raw coal, by wiping out the cost of disposal of ash and dirt, by doing away with uneconomical boiler and gas-producing plant, as well as the maintenance and labour costs involved in connection therewith, the case for cheap gas—which means crude coke oven gas—surely requires no advocate other than common sense.

Again, one hears everywhere the demand for a satisfactory smokeless fuel. To-day gas-works, coke ovens, and low-temperature plants are striving after this ideal. It can hardly be said to have been achieved as yet in a form which appeals to the public. To be satisfactory it must be clean, dry, physically strong, comparatively cheap, and finally, and probably most important of all, easily combustible. A great field here lies before the reconstructed coke oven industry; and from what one hears, those responsible will not be slow to seize every opportunity for exploiting to the full the possibilities of a proved system of rational utilization of coal.

General Report on Section H: The Composition, Classification, Preparation, Storage, and Handling of Gaseous Fuels and of the Products of the Carbonization Industry.

By T. CAMPBELL FINLAYSON.

This general report covers the seventeen papers comprising Section H—namely:

- A Systematic Classification of Technical Gases (Austria), by the Gesellschaft für Wärmewirtschaft.
- The Application of the Explosion Principle to the Evaluation of the Heating Value of Gases (Austria), by Dr. H. Löffler.
- The Testing of Gaseous Fuels (Austria), by Dr. Löffler and Prof. Müller.
- The Properties of Gases Defining their Combustion (Germany), by Drs. Bertelsmann and Schuster.
- The Production of Gas and the Recovery of other Products by Carbonization in the Vienna Municipal Gas-Works (Austria), by F. Menzel.
- Domestic Fuels other than Anthracite (U.S.A.), by the U.S. Bureau of Mines.
- The Fundamentals of Coal Blending and the Production of Solid Smokeless Domestic Fuel (Great Britain), by Dr. J. G. King.
- Gas Manufacture (Great Britain), by Prof. J. W. Cobb, C.B.E.
- The Purification of Coal Gas (Great Britain), by Charles Cooper.
- Coke Oven Practice and Developments in Bulk Carbonization (U.S.A.), by W. H. Blauvelt.
- Coal Carbonization in Japan (Japan), by Yoshikiyo Oshina.
- The Manufacture of Gas from Oil (Great Britain), by J. Kewley.
- Some Technical and Economic Aspects of the Bye-Product Ammonia Recovery Problem (Great Britain), by P. Parrish.
- New Methods of Fuel Analysis (Germany), by Prof. Bunte.
- The Development of the Coking Industry (France), by E. Langrogne.
- The Gasification of Fuels by Liquid Slag Producers (France), by A. Dessemond.
- Modern Methods for the Production and Utilization of Coal and Lignite Briquettes (France), by C. Berthelot.

The subjects covered by this group of papers are somewhat wide in their scope, but for the purposes of a general report may perhaps be grouped as follows:

1. Classification and analysis of gaseous fuels.
2. Gas manufacture—
   (*a*) Coal gas and water gas.
   (*b*) Gas from oil.
   (*c*) Gasification in liquid slag producers.
3. Gas purification.
4. Bye-product recovery.
5. The production of solid smokeless fuel.
6. Development in bulk carbonization.

CLASSIFICATION AND ANALYSIS OF GASEOUS FUELS.

In a paper presented by the Gesellschaft für Wärmewirtschaft, entitled "A Systematic Classification of Technical Gases," a standard method of describing and grouping technical gases is proposed. This plan, with minor alterations, has been adopted by the Austrian and German Standards Committee. It is felt that standardization on similar lines would be of international interest, and the authors suggest that a move in this direction might be looked for at this conference. The gases are grouped under gases from solid combustibles, from liquid combustibles, natural gases, and from non-combustible materials. These groups are further subdivided under process, general nature of gas, particular nature of gas, and finally calorific value. "The Properties of Gases Defining Their Combustion" are discussed by Dr. W. Bertelsmann and Dr. F. Schuster. They show that these properties are calorific value, air requirements, flame temperature, speed of ignition, ignition temperature, speed of combustion, explosive limits, and speed of explosion. Useful information is given for the determination of combustion calculations.

The subject of gas and fuel analysis is dealt with by three authors. Dr. H. Löffler, in his paper on "The Application of the Explosion Principle to Evaluation of the Heating Value of Gases," gives details of the explosion calorimeter, which is claimed as a speedy method of determining the calorific value of gases to an accuracy of 0·3 p.ct. The method depends upon exploding a measured volume of gas mixed with air in a spherical vacuum flask. Ignition is effected at the centre of the sphere, and the rise of temperature measured by a thermometer calibrated to read calorific value. The whole operation takes about three minutes.

In a paper from the Austrian National Committee, an account is given of gas analysis apparatus based on the ideas and designs of the late Prof. Strache. These consist of a simple apparatus for the determination of carbon dioxide, an instrument for taking temperatures in inaccessible places, an instrument for detecting gas leakages, and an apparatus for determining calorific values by explosion. A microcalorimeter is also described, by which it is claimed that an accurate calorific value can be obtained from a few cubic centimetres of gas—thus making an assay test more valuable.

Prof. Dr. Bunte contributes a valuable paper on "New Methods of Fuel Analysis," which deals particularly with the properties of fuels as they affect the carbonization industries. The scheme of fuel analysis as developed by the Gas Institute includes the determination of the melting-point of ash, the coking power of the coal, the calorific multiple of the gas in the case of gas coals, and the reactivity of the coke. The author recommends that the moisture determination for high bituminour coals should be made by the xylene distillation method, to avoid loss of bitumen or oxidation. He also urges the im-

portance of correct determination of reactivity of carbonized fuels, on which depends the behaviour of coke in gas producers, &c. Prof. Bunte, in concluding his paper, urges that the World Power Conference should discuss the proposed extension of methods of coal analysis.

Coal Gas and Water Gas Manufacture.

The processes and plants for the production of coal gas and water gas do not receive detailed consideration in any of the papers presented at this conference. This omission is, however, not a sign that there has been an absence of progress in methods of gas production. Prof. J. W. Cobb, in his general contribution on "Gas Manufacture," shows that the thermal efficiency of the carbonization process, allowing for the heat used and lost in the manufacture, has increased from 70 p.ct. in 1919 to 85 p.ct. at the present day, for a modern carbonizing plant with waste-heat boilers. A modern carburetted water gas plant works with an over-all efficiency of about 70 p.ct. Prof. Cobb puts forward the suggestion that with a steam-oxygen blast a simple continuous gas producer could be designed which would operate with an efficiency of 90 p.ct. He mentions that the price of oxygen has not yet been brought low enough. The efforts in many parts of the world to produce cheap oxygen would seem to show that realization of a supply at a sufficiently low price for employment in gas-making is a very long way off, if, indeed, it is possible to achieve.

In a paper entitled "The Production of Gas and the Recovery of other Products by Carbonization in the Vienna Municipal Gas-Works," F. Menzel states that their gas is made either in inclined chambers or in coke ovens with outside producers. A complete gasification plant on the Strache principle has also recently been installed. Every effort is made to improve thermal efficiency. This is effected by the low fuel consumption of the coke ovens, the efficient utilization of coke in central producers, the manufacture of steam from coke dust, and the use of excess steam to operate the ammonia and benzole plants.

Prof. Cobb, W. H. Blauvelt, and E. Langrogne, in their papers, refer to the developments in the use of surplus coke oven gas for town supply. Some idea of the magnitude of the use of coke oven gas in America may be formed from the statement that during 1926, 90,000 million c.ft. of this gas was distributed through city mains. Gas produced from coke ovens is assuming more and more importance as a source of coal gas for city use in America; more coke oven gas being purchased than coal gas made.

Gas Manufacture from Oil.

J. Kewley discusses the manufacture of gas from oil. Gaseous fuel undoubtedly offers the advantages of regularity of firing and ease of control. Considerable quantities of gas from oil are now being made and distributed from central gas-works in localities where oil is cheaper than coal—such as in California. Oil gas plants are of three types: Those which produce enriching gases, those which make oil gas in place of coal gas in central works, and those which make the gas on the site where it is required. The oil gas may be produced either by direct cracking, or by burning a part of the gas to supply the heat necessary for cracking the rest, or finally by making gas from interaction between highly heated oil and superheated steam. The author states that on large plants the oil consumption is 5·65 imperial gallons per 1000 c.ft. of gas of 500 to 600 B.Th.U. per c.ft. In the direct cracking process, operation is intermittent, the chambers being heated by air blast containing a little oil.

Continuous plants are built which work on the principle of effecting cracking by the heat supplied by partial combustion of the oil. Reference is made to the Hakol Zwichy process, in which conditions are controlled so that no carbon is deposited. When the gas is used for direct firing, about 95 p.ct. of the heat value of the original oils is available in the form of hot gas; if cooled, about 80 p.ct. of the heat is available. The Dayton plant, which operates on the same principle, is very compact; the output being 666 c.ft. per sq. ft. of ground space per day, with one man per shift to operate the plant.

Mention is also made of the Goldsborough processes for the production of high calorific value oil gas, which are at present in the development stage.

Gasification in Liquid Slag Producers.

With the object of utilizing low-grade fuels such as coal and coke screenings, a slagging gas producer has been developed in France. This is described by A. Dessemond. The slagging gas producer is fed with shale or screenings and coke breeze, scrap iron, and limestone. The producer is 2½ m. in diameter and 11½ metres high, and handles 100 to 150 tons of material per 24 hours, producing about 200,000 cub.m. of gas of about 1200 calories per cub.m. The blast is preheated in metal recuperators heated by producer gas. The products available for sale per 24 hours are about 60 tons of ingots and 40 tons of slag which when mixed with lime is used for cement manufacture. The producer gas after cleaning, cooling, and washing is used for heating purposes, either alone or enriched with coke oven gas.

Gas Purification.

Charles Cooper, in his contribution on the "Purification of Coal Gas," gives a comprehensive survey of the cooling and condensation of gas, tar extraction, ammonia washing, and gas drying. Dealing with cooling, the author compares water-tube condensers and washer-coolers. The latter consist of towers filled with suitable packing over which the cooled condensate is caused to circulate. He shows that, though the washer-cooler is cheap, it involves considerable pumping and increases the formation of toxic constituents which cause trouble in sulphate plant effluent disposal. Discussing tar extraction, Cooper states that the Cottrell process of electrical precipitation gives good results, but the cost of an installation is about three times that of a "P & A" apparatus. The author also gives consideration to the principles and methods of ammonia washing, and compares the theoretical and technical advantages of mechanical and tower washers. The process of drying coal gas prior to its distribution has been the subject of discussion in recent years, and the views expressed by the author will therefore be studied with interest. He compares the four main methods of dehydration, compression, refrigeration, chemical and physical absorption, and adsorption. In his view the most economical process is the drying of gas by means of a solution of calcium chloride, which is simple to operate and costs less than ¼d. per 1000 c.ft. of gas treated.

W. H. Blauvelt, writing on "Coke Oven Practice and Developments in Bulk Carbonization," shows how the operation of a coke oven plant and the yield of bye-products have been improved by the spraying of the hot gas in the collecting main with hot liquor at about 80° C., which causes the tars to come down and eliminate pitch troubles and consequent pipe-cleaning. The best results are found with 45 gallons per hour per ton of coal coked per day. The same author also mentions the use of liquid purification for the removal of hydrogen sulphide, which he regards as a notable step forward in the technique of gas purification.

Bye-Product Recovery.

The carbonization industries are at the present time faced with a serious problem in connection with the disposal of ammonia; and therefore the contribution by P. Parrish, on "Some Technical and Economic Aspects of the Bye-Product Ammonia Recovery Problem," is particularly opportune. The author shows that whereas the largest bye-product works produces 25,000 tons of ammonium sulphate per annum, Billingham, according to the modified schemes propounded by Lord Melchett at the Adriatic Conference, will produce 360,000 tons per year. P. Parrish urges that the recovery of ammonia at the majority of works should proceed only to the point of making either a concentrated gas liquor containing 15 p.ct. NH_3, or a solution of ammonium sulphate containing 40 p.ct. $(NH_4)_2SO_4$. These concentrated liquids should be converted into ammonium sulphate of uniform quality at a central works. The production of ammonium sulphate from anhydrite (calcium sulphate) is also dealt with, and the author compares the technical and economic aspects of the anhydrite process in comparison with the standard sulphuric acid process. He shows that for the treatment of bye-product ammonia, the anhydrite process requires a far more complicated plant than does the standard sulphuric acid saturator plant. The plant involves crushing, grinding, and screening machines, reaction vessels, CO_2 purification plant, special filter presses, evaporation plant, and rotary driers. The economics largely depend upon the price that anhydrite can be purchased at works. P. Parrish considers that the anhydrite process has an advantage in price varying from 8s. 8d. to 20s. 8d. per ton of sulphate of ammonia. He considers the process would not work economically on a plant to deal with less than 30 to 40 tons of ammonium sulphate per day.

The Production of Solid Smokeless Fuel.

The subject of smokeless fuel production is discussed in a number of the papers. Probably the outstanding paper is that by Dr. J. G. King, on "The Fundamentals of Coal Blending and the Production of Solid Smokeless Domestic Fuel." The author gives a very valuable historical survey of the stages in the development of the process of blending, apart from including much information from his own research work. He shows that from the point of view of smokeless fuel production, the blending of coals must be done by careful selection to ensure the right distribution and behaviour of the binder. He considers that the strongest cokes are obtainable by fine grinding of both constituents, but that the diluting particle may, if a suitable coal, be of larger particle size. When the diluent is coke, it must be finely divided. He believes that the period of carbonization of blends of coal should be such that the volatile matter remaining in the coke is 6 to 8 p.ct. Where coke is the diluent, this does not appear to be so important.

Prof. J. W. Cobb emphasizes that low-temperature carbonization is not the only way of producing solid fuel of high chemical reactivity which will burn cheerfully, and states that interesting results have been obtained in making coke more reactive by the addition of inorganic constituents such as sodium carbonate, oxide of iron, and lime. It is not claimed that the use of such cokes has yet reached commercial application.

In Japan work has been carried out by the Imperial Fuel Research Institute on the subject of reactivity of coke, details of which are given by Yoshikiyo Oshima in a paper entitled

"Coal Carbonization in Japan." Experiments are being conducted in regard to the improvement of coke manufacture, particularly from the point of view of determining proper carbonizing conditions for Japanese coal.

In a paper from the U.S. Bureau of Mines on "Domestic Fuels other than Anthracite," it is shown that coke oven coke is being successfully sold in competition with anthracite in many parts of America. There is a steady increase in the number of merchant plants, not connected with blast furnaces, which are engaged chiefly in the manufacture of foundry coke and domestic cokes. The American merchant plants in 1927 sold nearly 40 p.ct. of their coke output for domestic use. The volatile matter of such coke averages 0·7 to 2 p.ct., and the ash 7 to 15 p.ct. All the coke is sold in carefully screened sizes.

C. Berthelot, in his paper on "Modern Methods for the Production and Utilization of Coal and Lignite Briquettes," describes a new industry which is being developed in France for the production of artificial anthracite by the carbonization of suitable coal briquettes.

The process consists of heating up the briquettes at a carefully controlled rate.

Alternatively semi-coke or coke is finely powdered and mixed with tar or pitch, and briquetted. The briquettes are then distilled, and the main portion of the pitch is recovered.

DEVELOPMENTS IN BULK CARBONIZATION.

Three papers deal with bulk carbonization. W. H. Blauvelt, writing on "Coke Oven Practice and Developments in Bulk Carbonization," traces the modifications from the old beehive oven to the modern bye-product oven. The largest ovens in America to-day have a capacity of 20 tons per charge. Coking times have been greatly reduced, and one plant has a record of two months' operation at more than 1·3 in. per hour. This increase per unit of plant capacity and per man-hour has to a large extent offset the greatly increased cost of construction and wage rate since the early days of the industry. The author includes a valuable statistical summary of the United States coke and bye-product industry.

The U.S. Bureau of Mines, in their contribution, "Domestic Fuels other than Anthracite," also give in a diagrammatic form invaluable data relating to the economics of the coking industry. They show that a large number of coke oven installations have been erected specifically for the supply of town gas.

Dealing with the development of the French coking industry, E. Langrogne shows that coke quality has been improved by compression of the charge, high carbonizing temperatures, and reduction of coking time; the latter being obtained by the adoption of narrow ovens of silica material. Blending is now largely practised, and has only been made possible by the use of modern ovens.

AGENDA.

The discussion will be confined to the following: The desirability of standardization in describing and grouping of technical gases; the accuracy and applications of the explosion method of determining calorific values of gases; the production of smokeless fuel for domestic purposes at high temperatures, blending requirements of residual volatile matter, addition of inorganic constituents, carbonizing processes; developments in methods of gas manufacture, coal gas and oil gas; the technical and economic aspects of drying gas before distribution; the technical and economic aspects of ammonium sulphate production, anhydrite *v.* sulphuric acid; and developments in bulk carbonization, the effect of modern ovens on products of carbonization.

The Fundamentals of Coal Blending and the Production of Solid Smokeless Domestic Fuel.

By Dr. J. G. KING.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

[Extract.]

The trend of modern endeavour in this country towards the production of solid smokeless fuels has been mainly in the direction of providing a satisfactory fuel to replace the 40 million tons of coal at present being consumed in domestic appliances. The necessity for this is partly the alleviation of the smoke nuisance, to which the domestic fire is, perhaps, the main contributor, and partly to prevent the loss of bye-products involved.

Industrial smokeless fuels are less necessary owing to the general adoption of more efficient methods of combustion and to the adaptation of furnace grates to suit smokeless fuels such as gas-works coke.

The first step in the subsitution of raw coal for domestic purposes is obviously the production of a fuel which will give the desired results in appliances intended for the combustion of coal. This does not deny the presence of research, in the opposite direction, on the evolution of a type of grate which will burn efficiently such comparatively incombustible material as gas-works coke. While this side of the problem must continue to be attacked with advantage, it is nevertheless necessary that the new fuel give satisfaction in the modern grate.

In this country there are three types of domestic appliance to be considered, the kitchen range, the open fire, and the hot-water boiler. To these may be added the larger boiler for central heating. Low-temperature carbonization processes have already provided a material which gives excellent results in the open grate, and an increase of radiating efficiency over coal. In the domestic range the absence of flame during combustion makes it unsatisfactory for oven heating, except in those types of grate in which the oven flue is underneath, and the air supply is drawn through the fuel bed only. For hot-water boilers or central heating, the only precaution necessary for efficient use is the provision of absolute control of the air supply. The lower apparent density of cokes is a drawback for central-heating installations, but for the smaller water-heaters this drawback is more than offset by ease of ignition.

A partial solution of the problem may lie in the modification of gas-works practice to produce a coke which, while sufficiently strong and hard, would have the property of ready combustibility associated with semi-cokes. It has been shown that the modification of the fusion zone in coal and the maintenance of an open structure during carbonization is possible by careful blending of caking coals with non-caking coal, anthracite, or coke, and that the carbonized blend has the structure associated with semi-cokes.

A very good review of the factors governing the utilization of this process for the production of smokeless fuels, with special reference to modifications which may be adopted, has been given in the winning paper by E. W. Smith and his collaborators[1] in the Coke Competition organized by the "GAS JOURNAL" in 1925.

Several investigators, in particular J. Roberts, have demonstrated the superior combustibility of this type of coke to normal gas-works coke, but experimental evidence is still somewhat lacking in a quantitative sense.

Fishenden has shown that in three common types of open grate low-temperature coke shows an increase of efficiency of radiation over coal of 15, 23, and 27 p.ct. Bligh and Hodsman[2], using a special grate in which to burn gas-works cokes, have shown these to possess the same advantage over coal. In this grate the strong draught conditions were unsuitable for low-temperature coke, and it did not compare favourably with vertical retort coke. It may therefore be assumed that high radiation efficiency will be realized also with "blended" cokes, and also that the difficulties of poor ignition and the necessity for strong draught will not arise.

In Great Britain some 18 million tons of coal are consumed annually for gas manufacture. From this it may be assumed that less than 10 million tons of coke are available for sale, a quantity which represents only one-quarter of the domestic market. This consideration, and the fact that much of this coke is already very suitable for stoves, is a clear indication that the gas industry could, as at present constituted, supply only a very small portion of the domestic market. Any increase to meet the demands of this market would only result in the over-production of gas.

There is, nevertheless, considerable scope for rendering assistance to the campaign against smoke in making available for general domestic use as much of our gas-works coke as possible. Two obvious advantages to the producer are a more ready sale and the consumption of all coke breeze now being sold at relatively low prices.

EFFECT ON CARBONIZATION PRACTICE.

The necessity for fine grinding and intimate mixing of the constituents of the blend mean that static carbonization only is possible unless sizing after blending could be made a commercial proposition. In that case it is probable that greater advantages would accrue to flow systems by allowing of considerably increased throughputs of briquetted blends.

Some doubt exists as to the desirability of leaving fairly high percentages (6 to 8) of residual volatile matter in order to ensure ready combustibility. If it be assumed for the moment that

this is desirable, the following are considerations for and against the application of gas-making technique to the production of smokeless fuel.

Against.

(1) Cost of crushing and blending.
(2) Reduction in yield of gas per ton of coal.
(3) Handling of greater quantity of coal and coke for the same output of gas.
(4) Non-availability of all constituents for blending.

For.

(1) Utilization of all coke breeze made in the station.
(2) Increase in yield of gas per retort.
(3) Increase in calorific value of gas.
(4) Increase in monetary value of coke.
(5) Assistance in smoke-prevention campaign.

Cost of Crushing and Blending.

It has been quoted that the cost of crushing of coal for coke-oven practice is of the order of 0·48d. per ton of coal, so that it may safely be stated that the combined cost of crushing and blending should be more than compensated for by the elimination of breeze of low market value.

Output of Plant.

On a basis of gaseous thermal output, E. V. Evans and others have shown that, while the yield per ton of coal is less, the yield per unit of plant is actually greater, owing to the increased rate of heating. If the coke be discharged earlier, in order to leave 7 p.ct. of volatile matter in it, a reduction of the time of carbonization of almost half is rendered possible. Under such conditions the yield of gas is more than half the yield under normal conditions, and its calorific value is higher. The latter factor may also be of importance.

If carbonization be continued to the usual stage of low volatile coke, the full yield of gas is obtained in a less time. Thomas has shown a time reduction of 16 p.ct. and Evans of 28 p.ct. for the same thermal output. If coals only are being blended, the balance in favour of blending is, therefore, very apparent when throughput is considered. If coke breeze is used, the advantage is less apparent, as the coke is obviously non-productive in a gas-making sense. Evans has, however, shown that the throughput of *coal* is not decreased by the use of coke; a 25 p.ct. reduction in time of carbonization being realized with a 20 p.ct. coke blend.

T. C. Finlayson[3], in stressing the importance of flexibility in gas manufacture, shows how it is proposed to ensure this, together with higher efficiency, by separating gas coals into lump and small. The proposal is in connection with the installation of new plant for the Dawsholm Works, Glasgow. The Scottish coals available are of the type which in lump form give high throughputs in vertical retorts. It is therefore proposed to carbonize the coal of over 1 in. particle size in continuous retorts, and to blend the remaining fine coal for charging into Woodall-Duckham chamber ovens. Suitable control of blending will then ensure reduction of period of carbonization, and the production of combustible coke. Preliminary work on blending for such ovens is being conducted by the Research Section of the Woodall-Duckham Company at Ramsgate, with the co-operation of the Engineer, Mr. Ruthven.[4] This type of chamber oven seems particularly suitable for such work, though a narrow coke oven such as was used in early experiments by the Woodall-Duckham Company is also suitable; the only difficulty being that of possible crushing of uncarbonized material during discharge.

A further advantage of increased rate of throughput is the increased thermal efficiency of the process, as the heat dissipated by radiation, &c., is a function of time and not of throughput.

Constituents of the Blend.

Coke breeze is always an available constituent, and it is possible that all the breeze now produced could be utilized for this purpose if blending were resorted to for only a portion of the coal carbonized. If the full value of blending is to be realized, however, it is necessary to visualize the utilization of as much non-caking coal as possible. In some districts both types are readily available, but in others the added cost of freight or pre-treatment may outweigh the advantages of blending.

Combustibility of Coke from Blends.

The value of a coal substitute must be regarded to a large extent in the light of its combustibility. Such factors as amount of ash, absence of clinker and soot, and cleanliness in handling, while of domestic importance, must be secondary to the important consideration of a bright, cheerful fire. It is now generally recognized that semi-coke is a very promising substitute for coal, and in the following experiments the standard of comparison chosen has been semi-coke made by carbonization of coal in the low-temperature retorts at H.M. Fuel Research Station. The test employed was the simple and arbitrary one of igniting in a cold grate of well type 8 lbs. of the fuel, and observing the horizontal component of radiation until the fire had burned down. The test is described here strictly as a means of comparing cokes, and the results have no absolute significance. The points of comparison are the amounts of gas necessary to start combustion, the time taken to reach the point of maximum rate of radiation, and the rate of radiation at that point.

The first point to be considered was whether residual volatile matter played a part of any importance in determining combustibility. Using low-temperature coke made in the Fuel Research Station vertical retorts as a basis of comparison, low-temperature coke prepared in a smaller retort but from the same coal was carbonized at an external temperature of 600° C. and then heated to 900° C. to remove most of the residual volatile matter. The results as shown in the appendix and in fig. 1 are striking. The coke prepared at 600° C. contained 8·5 p.ct. of volatile matter and behaved similarly to the standard of comparison. The heated coke, in which the volatile matter had been reduced to 2·7 p.ct. burned up more slowly and attained its maximum rate of radiation at a much later period.

Residual volatile matter, p.ct. . .	8·5	..	2·7
Gas for ignition, B.Th.U.	1120	..	1120
Time to reach maximum rate of radiation, mins.	80	..	105

It may be assumed from this experiment that if domestic smokeless fuel is to be made in gas retorts by blending, it is desirable to leave in it some 5 to 8 p.ct. of residual volatile matter. Such an arrangement is not difficult, for, owing to the control of the plastic zone, the differences in volatile matter throughout the charge are not nearly so great after the lapse of about half the carbonizing period as when using coking or gas coals alone.[5]

Experiments on these lines were suggested to the Director of Fuel Research by J. Roberts, but no experiments other than those described herein have been carried out.

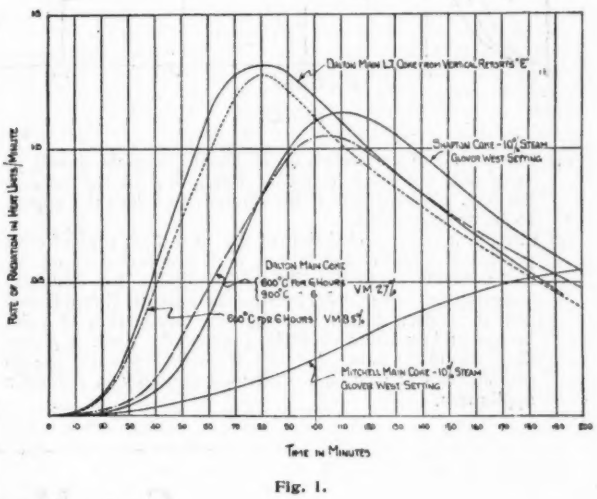
Rate of Radiation in Heat Units/Minute
Time in Minutes
Dalton Main LT Coke from Vertical Retorts "E"
Shipton Coke - 10" Steam Glover West Setting
Dalton Main Coke
900° C for 6 Hours
600° C - 6 -
VM 2·7%
600° C for 6 Hours VM 8·5%
Mitchell Main Coke - 10" Steam Glover West Setting

Fig. 1.

Under the conditions of this simple combustibility test, the type of coke made in gas retorts compares unfavourably with low-temperature cokes. Coke from Glover-West retorts is difficult to ignite, and gives a flat curve (fig. 1), while that from a horizontal retort could not be made to burn at all, though the centre of the fire was raised to a dull red heat by the gas lighter. Comparison under these conditions is not, of course, intended to discount the evidence of other experimenters who have shown that gas-works coke can be made to burn in other grates and under other conditions.

In fig. 1 is also shown the curve for coke made in a Glover-West retort from a selected lump coal not normally used for gas-making purposes. This coal possessed in itself the correct amount of binder for the control of the fusion zone, and might be regarded as a blend in which the individual particles were in closer contact. The curve indicates as good a fuel as the low-temperature coke with 2·7 p.ct. of volatile matter, and is a very considerable improvement on the normal vertical retort coke. From a gas-making point of view, this coal gave quite good results; and it is conceivable that it might well repay a fortunately situated gas company to consider the carbonization of medium caking coal of this type in vertical retorts. The process would probably necessitate screening and the blending of the finer coal for charging to horizontal retorts or ovens.

Similarly, artificially prepared blends would give the same results if sizing by briquetting were resorted to. The more promising procedure is, however, to carbonize stronger blends in horizontal retorts or ovens. Fig. 2 shows curves obtained from two coal-coke blends prepared at the Fuel Research Station. All these cokes give satisfactory results, but the best is that made from gas coal and coke. The high combustibility of this coke is of special interest in that the charge was given a full period of carbonization Though this point has not yet been proved, it is possible that finely divided coke gives a final structure which is more readily combustible than that given

by blended coals. In such a coke, also, the leaving of residual volatile matter does not seem so necessary.

CONCLUSION.

From this consideration of the subject of blending from the point of view of smokeless fuel production only, it may be concluded that:

(1) The blending of coals must be done by careful selection to ensure the right distribution and behaviour of the "binder."

(2) Cokes considerably more dense than low-temperature fuels can be made by high-temperature carbonization of blends of gas coals or coking coals with weakly-caking coals or cokes.

(3) The strongest cokes are obtainable by fine grinding of both constituents, but the diluting constituent may, if a suitable coal, be of larger particle size. When the diluent is coke it must be finely divided.

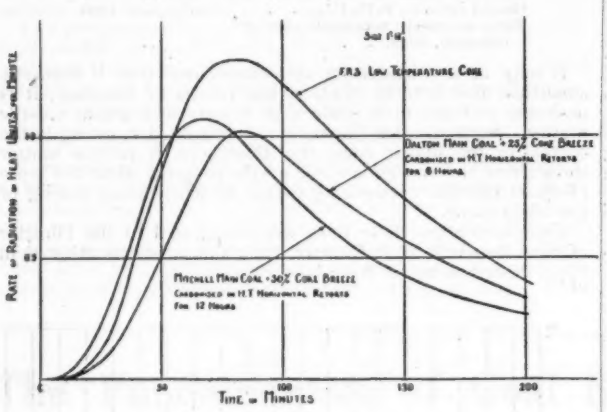

Fig. 2.

(4) The period of carbonization of blends of coals should be such that the volatile matter remaining in the coke is 6-8 p.ct. Where coke is the diluent, this does not appear to be so important.

(5) Finally, it is concluded that of the 10 million tons of coke produced annually for sale, a high proportion could, by the methods suggested, be made suitable for domestic consumption without decreasing the gaseous thermal output of modern plant, and that the production of coke breeze of low value could be prevented. Such a procedure would go some distance towards replacing the 40 million tons of raw coal consumed annually in domestic appliances.

APPENDIX.

COMBUSTIBILITY CURVES.

The curves shown in figs. 1 and 2 in the paper were obtained by the combustion in a well grate, under identical conditions, of equal quantities of the cokes. The data collected for comparison were, gas required for ignition, rate of radiation in a horizontal direction, and weight of unconsumed fuel. Each fire of 8 lbs. was lit by means of a gas burner and allowed to burn out without disturbance. The coke was crushed and screened to a uniform size (1¼ to 1 in.) and air-dried.

It is emphasized that this test is regarded as a comparative one only, and that in more suitable grates normal gas cokes can be made to burn with considerable success.

The results discussed in the paper are given in the following table, the various samples examined being:

(1) Low-temperature coke produced in the vertical retorts at H.M. Fuel Research Station described in F.R.B. Technical Paper No. 17. The coal used was Dalton Main and the carbonizing temperature 625° C.

(2) Low-temperature coke produced in a similar but smaller retort at the Fuel Research Station.

(3) Coke No. 2 prepared at a carbonizing temperature of 625° C. and subsequently heated to 900° C. remove volatile matter.

(4) High-temperature coke produced from Mitchell Main coal under the conditions of gas manufacture in a Glover-West retort employing 10 p.ct. of steam.

(5) High-temperature coke as in (4) but employing, in lump form only, a coal of caking power less than average and not generally utilized for the purpose of gas manufacture.

(6) High-temperature coke made by the carbonization in a horizontal gas retort of a blend of 75 parts of medium caking coal with 25 parts of fine coke.

(7) As for (6) but with 70 parts of a gas coal with 30 parts of fine coke.

Type of Coke.	Volatile Matter P.Ct.	Gas for Ignition B.Th.U.	Time to Maximum Rate of Radiation. Mins.	Maximum Rate of Radiation per Min.	Amount Consumed P.Ct.
1*	6·5	1120	80	1·32	75·0
2	8·5	1120	80	1·28	71·5
3	2·7	1120	105	1·04	66·8
4	1·0	2800	220	0·58	46·0
5	1·0	2400	110	1·07	65·0
6†	1·0	1120	83	1·02	59·0
7†	2·5	1400	68	1·07	60·0

* Used as standard of comparison.

† A coal blend carbonized in the horizontal retort gave a coke which could not be ignited under these conditions.

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[4] "GAS JOURNAL," 1928, 181, 397.
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Gas Manufacture.

By Prof. J. W. COBB, C.B.E.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

[Extract.]

In practice, there is a limitation of general application to the value of comparison by thermal efficiency alone. It is vital when the possible expansion of the industry is in question, particularly into the industrial field. It is the consideration which makes the financial balance-sheet the final arbiter, and arises from the fact that the thermal cost is by no means the only cost which gas has to bear in its production. The following table for works of different sizes illustrates this point. It is there made plain that bounds are set to the replacing of coal by gas by the monetary cost of carbonization in gas supply for which plant has to be supplied and worked not only for carbonizing coal or gasifying coke, but for condensing, washing, purifying, storing, and distributing.

The thermal efficiency obtained in the best works by the gas industry, and with the latest plant, carefully supervised, is high, though, as in the parallel case of steam raising, there is much to be done and large economies to be secured by bringing the worst up to the average and the average up to the best. Thermal efficiency is, however, not the whole story. It is, I believe, fully realized by the gas industry that the replacement of coal by its products will gradually increase in proportion to the extent that its net costs can be kept down in any way by increase in thermal efficiency (for which in its strictest sense the room is limited), by increasing output, by diminishing capital and other expenditure per unit of operating plant, by utilizing all possible sources of fuel supply, whether coal, oil, or unused gas, and by increasing as much as possible the value of all its products and bye-products. To these problems the gas industry is addressing itself in various ways. Economies and developments may be briefly indicated. Some commercial and technical reorganization is possible from the amalgamation of undertakings, and some from the fuller utilization of coke oven gas, for which there is a *prima-facie* case,

TABLE I.

—	Gas Light and Coke Company.	Tottenham Gas Company.	Barnet Gas and Water Company.
Therms in gas made	182,854,595	14,834,970	1,350,097
	d.	d.	d.
Coal and oil	4·92	5·24	6·78
Receipts from residual products—			
Coke	2·42	2·01	3·30
Tar	0·73	0·85	0·88
Ammonia	0·30	0·20	0·18
Total from residuals	3·45	3·06	4·36
Coal, &c., less residuals	1·47	2·18	2·42
Net cost in holders (including purification, salaries, maintenance, wages)	4·40	5·78	5·23
Rates and taxes	0·73	0·45	0·67
Distribution (including maintenance of pipes and meters)	1·60	2·18	1·85
Capital charges	1·96	1·70	not given
Net cost of gas	7·20	9·21	8·03

since between 3000 and 4000 c.ft. of gas per ton of coal carbonized in coke-ovens would, on the average, be available after providing for the heating of the ovens. The difficulties to be faced in using coke oven gas are such as those of intermittent supply due to break-down at the colliery, complete cessation of the supply during coal strikes, variation in quality, the necessity of having sufficient reserve plant in order to meet any sudden failure of the supply of coke oven gas, maintenance of long length of main, consideration of the position at the end of any contract made when supply would be discontinued and any mains would be of no use, and cost of pumping gas over long distances. These things all require careful consideration.

Other developments may arise when the process of carbonization has been far more thoroughly and systematically studied than has been the case in the past. Much work is being done in this direction.

Factors Influencing Carbonization.

It is necessary to evaluate separately the factors influencing the results of carbonization, and that is by no means a simple process. When, however, the choice of coals, their cleaning, size, crushing, blending, and treatment at different rates, temperatures, &c., of carbonization have all received proper attention, no one can foretell the technical and commercial results that will become practicable. The existing carbonization processes provide a centre of sound established practice, but will probably have to be varied in detail or even in their main features to meet different requirements. The production of smokeless solid fuel more suitable for domestic use than ordinary gas-works or coke oven product is an example. The most obvious plan for that purpose seems to be carbonization at a lower temperature, but that would be a reversion for the gas industry, which has developed in the direction of increasing the yield of gas—that is, of the product which gives the greatest enhancement of value, in both the thermal and the monetary sense. If the gas yield dropped to one-half, the whole outlook of the gas industry would be altered. Moreover, making coke at a low temperature has been shown to be only one way, and not at all necessarily the best, of producing solid fuel of high chemical reactivity which will burn cheerfully. Altering the conditions of operation in carbonization, apart from temperature, influences the cellular structure of the coke and alters its properties in various ways; and interesting results have been obtained in making coke more reactive by the addition of inorganic constituents, such as sodium carbonate, oxide of iron, and lime. Rapidity and cheapness in carbonization are plainly desirable, and for this purpose it is probably not so much low temperature in the charge carbonized that will help, as the construction of apparatus and the method of working, which will allow of a high temperature head and effective penetration of heat to the charge. For this reason every effort is justified in the endeavour to improve the quality of refractory materials, both as allowing the use of high temperature heads and of prolonging the period over which structures can remain comparatively gas-tight and efficient in operation. There is some tendency to secure simplicity by carbonization in bulk, and large chamber retorts are receiving extensive trial in that connection. Exactly the opposite tendency, but still sound in principle, is seen in processes where the greatest rapidity of output is sought by carbonizing the charge in dust form, each particle being subjected to the effect of an ascending current of hot gas. As at present worked, however, this process does not yield gas of a sufficiently high grade for public supply. Another method in which simplification is being sought is in the direct gasification of coal instead of coke in the water gas plant, with necessary modifications which may be extensive. In this connection it may be pointed out that on some of the highly reactive cokes prepared with the addition of inorganic constituents, the rate of gasification obtainable in a current of steam or CO_2 may be increased in some cases ten or twenty times, without lowering the quality of gas produced below a high standard. The following table is of interest in that connection:

No claim can be made that the use of such cokes has reached the stage of successful commercial application, but the possibilities are fascinating, and it introduces the principles of controlling the nature of the fuel gasified. There are specially possible applications which may be mentioned, such as that of making a fuel which can be gasified with great rapidity in portable generators for motor transport.

Table II.—*Gasification of Special Cokes in Steam and CO_2.*

Coke Used.	Weight of Coke. Grammes.	Gas Entering.	Rate of Gas Entering. Litres per Hour.	Rate of Coke Gasification. Gms./Hr.	CO_2 P.Ct. in Gas Leaving (Dry).	CO P.Ct. in Gas Leaving.	Temp. Fuel Bed. °C.
"Pure"	10	Steam	2·5	1·15	5·2	..	1000
5 p.ct. Fe_2O_3	10	,,	21·9	10·5	5·0	..	1000
5 ,, CaO	10	,,	11·2	5·2	5·4	..	1000
5 ,, Na_2CO_3	2·5	,,	19·0	..	5·8	..	1000
	10	,,	21·0	..	0·4	..	1000
"Pure"	10	Steam	10	0·9	18·0	..	800
5 p.ct. Na_2CO_3	10	,,	10	5·8	1·7	..	800
"Pure"	10	CO_2	6	..	..	47·8	1000
5 p.ct. Fe_2O_3	10	,,	6	..	..	93·0	1000
CaO	10	,,	6	..	..	95·0	1000
Na_2CO_3	10	,,	6	..	..	97·0	1000
"Pure"	10	CO_2	6	..	..	14·0	900
5 p.ct. Fe_2O_3	10	,,	6	..	..	70·0	900
CaO	10	,,	6	..	..	63·0	900
Na_2CO_3	10	,,	6	..	..	82·0	900

If Cheap Oxygen were Available.

There remains for mention the radical simplification which could be effected in gas-making processes if cheap oxygen could be supplied instead of air. It is quite true that at present and for the immediate future the production of a solid smokeless fuel must be regarded as very desirable. The main reason for this, in the opinion of the author, is simply that there is no refuse destructor comparable for general usefulness with the solid fuel fire, and the problem of sanitation is greatly simplified by the existence of one solid fuel fire in each house, serving not only as a heater but as a destructor. Surely, however, this difficulty will be overcome, and we shall be able to take full advantage of the higher thermal efficiency, cleanliness, convenience, and labour-saving qualities of gas as a fuel. A process of complete and continuous gasification is surely the ideal. The price of oxygen has not yet been brought low enough, but when that has been attained it seems likely that gasification could be effected not only with a high thermal efficiency approximating to 90 p.ct., but in a simple continuously working apparatus of the gas-producer type.

Other developments in the gas industry are inevitable in the processes of condensing, washing, and purification. The effluent problem is serious and must be solved. Proper thought and design, even in existing plants, will lessen the quantity of that effluent; while bringing down the tar as quickly as possible, separating it as soon as possible from the liquor, and minimizing the contact with oxygen, particularly while the tar and liquor are hot, will lessen the production of harmful ingredients. Chemical processes for the extraction of phenols from liquor are being studied.

Tar is a large subject in itself, but so choosing and treating coal tar as to give it the properties of an ideal road-binder is an aim of immediate importance to which reference should be made.

The ammonia question has become serious because of the lowering of prices resulting from the development of the synthetic process. It is unfortunate that not one of the processes making the sulphur in the coal the source of the sulphur in ammonium sulphate production has so far met with commercial success. Under the conditions of to-day, liquid purification may have better prospects than appeared likely twenty years ago. The removal of H_2S by oxide of iron, although efficient, is much too cumbersome and expensive in plant and labour, while hot oxide purification does not seem to have been worked out to a satisfactory conclusion.

The Purification of Coal Gas.

By CHARLES COOPER.

Authoritative Body: Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

Cooling and Condensation.

Cooling of crude gas by air is too uncertain a method, particularly where the gas has a steam content above the average, and it is now for all practical purposes obsolete. The problem is conveniently taken up starting at the dew-point of the crude gas, as the temperature fall to this point, though it may be due only to air-cooling and radiation, is easily attained owing to the high-temperature gradient obtainable, and the relatively small quantities of heat involved in a given temperature drop, when handling unsaturated gases.

The features common to all heat exchange questions (such as the relation of film coefficients to velocity, and the effects of turbulent motion) all occur, but the cooling of mixtures of steam and permanent gases possesses special features. The main ones are that the heat load per degree of temperature varies with the vapour pressure of water, and that the trans-

mission coefficients alter according to a somewhat similar fashion.

In the "Report on Condensing and Scrubbing" published by the American Gas Association in 1925,[1] a study is made of this particular heat-exchange, and a very convenient method for analysis of results and for design of coolers is given. This method uses a mean temperature difference over the required range which is obtained graphically, and deduces a mean over-all heat transfer coefficient for the same range.

Fig. 1 shows details of a test carried out on a horizontally tubed condenser installation. In this construction the water makes a large number of passes between headers, and allows of the determination of the change of temperature during passage through the condenser.

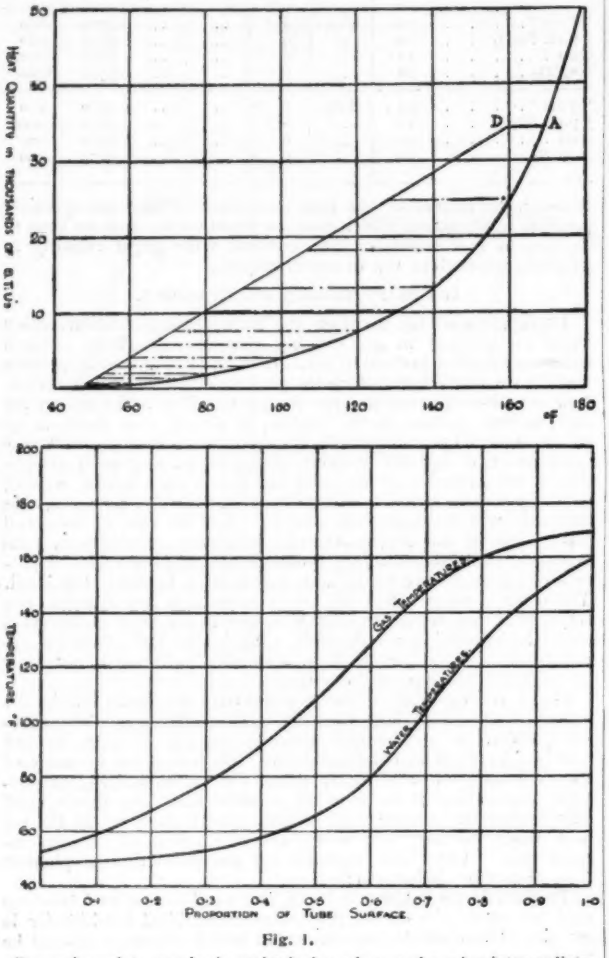

Fig. 1.

Drawn from data on a horizontal tubed condenser observing intermediate temperatures.

Gas inlet temperature	. . . . .	A	169° Fahr.
Gas outlet ,,	. . . . .	B	52·8° ,,
Water inlet ,,	. . . . .	C	48·7° ,,
Water outlet ,,	. . . . .	D	159·4° ,,
Cooling surface	. . .	48 sq. ft. per 1000 c.ft. per hour. = 2 sq. ft. per 1000 c.ft. per day.	
Linear velocity of gas at 70° Fahr.	. . .	6 ft. per sec.	

NOTE.—The heat quantities given are about 8 p.ct. lower than calculated from fully saturated gas and steam mixtures, but give accurate heat balance for the tests quoted.

Consequently it is possible to apply the calculation by the method of Haug and Mason to any temperature range desired, and to find the transfer coefficients for restricted ranges or for particular temperatures, under conditions of practice. Fig. 2 shows the coefficients for various temperatures (determined actually for the range ± 5° Fahr.) for velocities of 6 and 4 ft. per second. These velocities are calculated from the volume of gas measured at 60° Fahr. and 30 in. pressure, and the effective cross-section.

Some of the indications obtained by this means were:

(*a*) Where the water temperature approaches the inlet gas temperature very closely, the transfer coefficient at the highest temperature falls below the expected value, suggesting that the gas is really slightly unsaturated.

(*b*) Comparing the coefficients over the same range as between various types of condensers, it is found that they are nearly double, in the case of these horizontally tubed condensers, those of the vertically tubed condensers quoted by Tooby,[2] and

[1] Method of Haug and Mason. The U.G.I. Company, Philadelphia, U.S.A.

[2] C. F. Tooby. Corporation Gas-Works, Coventry. See "GAS JOURNAL," 176, p. 228.

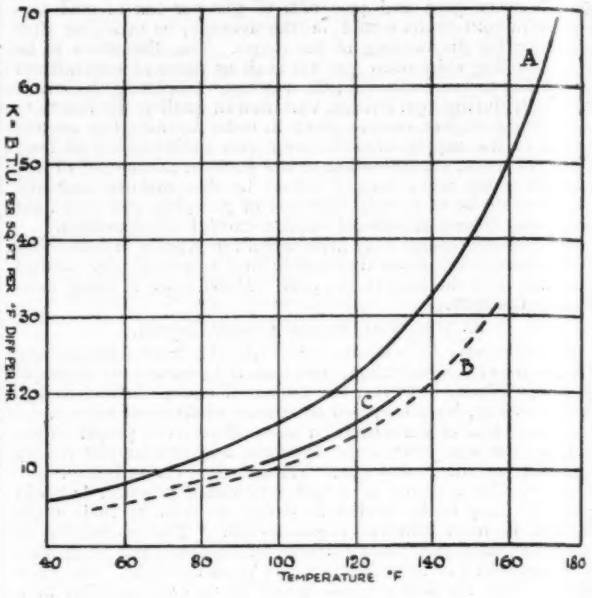

Fig. 2.

Showing values of K at temperatures 40° to 170° Fahr. for various velocities,

Curve A: Determined from seven separate tests similar to fig. 1.
,, B: Calculated from the values on Curve A, for velocity 3·6 ft. per second, in ration of 0·76 root of relative velocities.
,, C: Calculated for 4 ft. per second, and showing in full portion exact confirmation from tests on an entirely different installation.

approach closely to those for direct cooling given by Rosebaugh.[3] Comparison with the special construction described by Tindale[4] is more difficult, but actually appears to show lower coefficients for the latter.

TABLE I.—*K. Values over Various Ranges.*

Lower Limit.	Upper Limit.							
	169° F.	160.	150.	140.	130.	120..	110.	100.
120° Fahr. . . .	35·5	34·4	29·9	24·5	20·0	..	..	..
110° ,, . . .	33·7	31·9	27·5	22·6	20·3	20·2	..	..
100° ,, . . .	32·3	29·7	25·1	21·1	19·2	19·2	19·2	..
90° ,, . . .	31·0	28·0	23·5	19·7	18·4	18·4	18·2	17·2
80° ,, . . .	28·5	24·9	20·4	17·3	15·6	15·1	14·1	12·0
70° ,, . . .	25·6	21·5	17·2	14·4	13·0	12·3	11·4	9·0
60° ,, . . .	22·6	18·2	14·5	12·0	10·7	10·1	9·3	8·0
53° ,, . . .	20·7	16·3	12·9	10·8	9·7	9·2	8·6	7·7

Table I. shows the over-all coefficients for various temperature ranges for this type of condenser, obtained by the method outlined above. The figures for the higher ranges agree well together for various determinations, provided that the range does not include the immediate point of entry of the gas.

Consistent results will, of course, only be obtained when the tube surfaces are in normal condition. Deposits of naphthalene occur in some cases in the cooler parts, and in other cases adherent coatings of pitch or dust. To deal with such eventualities, it is often the practice to arrange for reversal of the flow of gas, to obtain the benefit of the high temperature, for example, to remove the naphthalene. Dr. Carpenter's[5] method is shown in "Modern Gas-Works Practice" by Alwyne Meade, and a different construction of connections for the same purpose, for a condenser of two passes, is described in E.P. 272,293/1926.[6]

DIRECT COOLING.

The washer-cooler is most commonly met with in the United States, where it has in many places displaced the tubular type. It consists of one or more towers with suitable packing, over which the cooled condensate from the gas is caused to circulate. The heated liquid leaving the tower is thereafter pumped through nests of pipes exposed to the air, and over which the cooling water is flowing. The essential data for this apparatus were published by Steere,[7] and an abstract is given in Table II.

[3] T. Rosebaugh. Pacific Gas and Elec. Co., San Francisco, U.S.A. "Chem. and Met. Eng.," March, 1928, p. 144.

[4] H. Tindale, Sydney, Australia. "Gas Age Record," Feb. 11, 1928.

[5] C. Carpenter. South Metropolitan Gas Company. See A. Meade. "Modern Gas-Works Practice."

[6] D. M. Henshaw. W. C. Holmes & Co., Ltd., Huddersfield. See also [11].

[7] F. W. Steere. Steere Eng. Co., Detroit, Michigan, U.S.A. A.G.A. 1922 Convention.

A detailed examination of these coolers, on the lines of the A.G.A. report above mentioned, has been made by Rosebaugh.[8]

TABLE II.—*Data on Washer Cooler Sizes.*

Gas Inlet Temp.	Galls. of Liquor per Minute.	Sq.Ft. of Cooling Coils.
° Fahr.		
120	0·22	6·6
130	0·26	9·3
140	0·31	12·8 — Per 1000 c.ft. per hour.
150	0·38	17·9
160	0·49	26·3

Water consumption, about 0·75 gall. per gall. of liquor circulated.
Area of filling, 5 sq.ft. upwards, per 1000 c.ft. of gas passed per day.

The washer-cooler is undoubtedly cheap, but exhibits a few disadvantages. It is usually worked in connection with the so-called intensive ammonia washer, which it resembles; it does not appear to give as good tar extraction as might be expected. It involves a considerable amount of pumping apparatus, and it does not appear from published data to have any special merits as regards water economy.

It is also to be noted that the repeated handling of liquors is regarded to-day as promoting the formation of those constituents which render ammonia plant effluents highly toxic.[8]

On the other hand, the washer-cooler appears to be adaptable to dirty or corrosive waters, which are troublesome in tubular condensers. Salt water in the latter demands cast-iron tubes, thus raising the first cost.

An apparatus and principle similar to the washer-cooler are employed by Still[9] in connection with direct ammonia recovery, and is described in his specifications. The work of Feld in connection particularly with the control of the composition of condensates is also important, and can be read in a broad form in the book "Coal Gas Residuals" by F. H. Wagner.[10]

It is a convenient practice to employ the tubular condenser as the feed-water heater for the gas-works boiler, particularly for waste-heat boilers in the retort house. Usually the feed-water requirement is below the demands of the condensers, and it has been found[11] that the best method is to divide the duty on the latter, using the boiler feed at the hotter end of the condenser, and perhaps employing an excess of an inferior water for taking the rest of the duty. This method of feed-water heating is not readily applicable to exposed coolers such as the washer cooler.

Another type of direct cooler is employed in the direct system of ammonia recovery in coke oven practice. This usually consists of an empty column down which a powerful jet of cold water is directed. The water requirement is very heavy, and the water is difficult to recondition so as to make it suitable for further use, or for discharge as an effluent. The fact that the hydrocarbons brought down consist largely of naphthalene is chiefly responsible for this design.

TAR EXTRACTION.

An excellent survey over the field of tar extraction at the date of its publication is that of Clayton and Skirrow.[12] These authors describe the different types in current use, and discuss methods of estimation of tar fog content.

The most common principle is to employ the difference of density between the tar droplets and the gas to promote separation. The best known apparatus is probably the Pelouze and Audouin, wherein the gas is fairly finely divided into streams, and subjected to a series of quick changes of direction by impinging on steel plate surfaces. Others are the cyclone type which is familiar also for the separation of dust suspensions; and fans of varying construction, whose beating and centrifugal action also depend on a high relative velocity.

The recent employment of centrifugal exhausters at very high speeds has been found to give improved results in tar extraction, one such machine being said to obviate the necessity of any tar extraction plant other than this. Speaking generally, however, a definite proportion of the tar fog will escape any such apparatus as is included in this class, for the difference of density becomes less effective as the particle size is reduced.

The means employed in the Livesey washer, and its American anti-type called the static or multiple washer, appear to be fundamentally different, as such high velocities are not used. In these plants the finely divided gas streams are passed through a few inches of ammoniacal liquor. Undoubtedly surface tension conditions are important in this extractor. It is often favoured for the additional ammonia washing capacity which it simultaneously confers.

Since the advent of vertical retort practice, it is the general experience that good tar extraction is more difficult in such circumstances. This may, in rare cases, be due to condensers becoming inadequate in capacity when turned over from straight gas-making in unsteamed retorts, to steamed gas from verticals; but apart from this the tar fog is more persistent in the gas.

One factor which may contribute to the condition stated is that the vertical gases contain a greater proportion of light oils, and condensation of such oils may still be going on at lower temperatures than were required to effect substantially complete condensation, under the conditions of horizontal retort practice.

It was until recently considered essential to good tar extraction to pass the gas into the tar extractor at a temperature of 90° to 100° Fahr., and to have secondary condensers to complete the cooling of the gas. This appears to have been connected with the matter of the viscosity of the tar produced under horizontal retort conditions with high heats. Such precaution is not usually taken when dealing with the lighter tars from vertical retorts, and it is probably best to cool the gas as completely as possible before the final tar extraction.

ELECTRICAL PRECIPITATION.

An interesting and comparatively recent development is the application of the high-tension electric field to the resolution of tar fog. The Cottrell process[13] is in use in several works in the United States, chiefly very large ones. A constant high potential gradient of the order of 10,000 volts per inch of space is maintained, and the tar drops and vesicles, picking up a negative charge, are thereby attracted to the anode, and are collected thereon.

The principle is simple and the results claimed are very good. The chief feature requiring careful attention appears to be the maintenance of the insulation in the gas space, and not much trouble appears to arise if the insulators are regularly cleaned. The cost of an installation on these lines appears to be about three times that of a "P. & A." apparatus, and there is an operating cost of (say) 0·1d. per 1000 c.ft. as cost of current, for an installation of 5 million c.ft. daily capacity (cost of current taken at 1d. per unit).

The importance of tar extraction appears chiefly in two directions. It has been repeatedly shown that the earlier the tar is removed from the condensing system, the less is the tar-acid content of the ammonia liquor produced. The liquors produced in the later stages of condensation undoubtedly absorb tar acids in greater proportion than those first deposited. On the other hand, a gas cleaned from tar fog is more easy to treat in the later stages of purification, ammonia washing and sulphur removal. Tar reduces the efficiency of most ammonia washers, whether mechanical or static; and it is easily shown that a very moderate deposit of tar in an oxide purifier can put it out of action, at least temporarily. The loss of tar in such suspensions as are usually found where tar extraction is faulty is seldom important, but the ill-effects can be serious.

AMMONIA WASHING.

The removal of ammonia from crude gas by washing with water is still the general practice in gas manufacture, as distinct from its removal by direct contact with an acid, which is found most generally in coke oven plants. It is at the first view the simplest method to adopt, as there is already formed a certain amount of aqueous solution in the condensing process. Another factor, however, which makes water washing a convenience in gas-works is that the rate of production is far from uniform. There is the seasonal variation of demand, and there is also in many works a daily cycle of variations, dependent on the system of retort charging; on the coke works there is no variation if it can be avoided. Thus the various direct systems of sulphate of ammonia manufacture found in the latter works can be operated on a constant and preferably a maximum rate; but on the other hand, the indirect ammonia plant can be operated for definite spells at its maximum rate in spite of the varying rate of production, by arranging for the storage of the ammonia liquors made by washing with water.

From a good British gas coal we may expect to obtain about 7 lbs. of ammonia per ton of coal carbonized. The quantity of water in the crude gas will vary between (say) one-tenth and one-fifth of the weight of the coal, depending on the retort house practice. If no more water than this were brought into the system, the ammonia solution which could be made would have a strength of between 3 p.ct. and 1·5 p.ct.

The condensation process does not, however, give such complete removal, and the quantity of water which has to be employed to absorb the residue depends on the volume of gas to be treated; the temperature of the washing system; and the efficiency of the washing plant.

To a minor degree it also depends on the concentration of ammonia in the gas. This follows from the fact that a certain amount being allowed to remain in the gas, the proportion of removal required will rise or fall as the original content is higher or lower.

The accommodation of a fixed washer capacity to this requirement is naturally made by increasing or decreasing the water

[8] A. Parker. University of Leeds. Paper to Joint Carbonization Conference, Birmingham, Feb. 21–24, 1928. "GAS JOURNAL" Carbonization Number. Also H.M. Inspector of Alkali Works Reports —1923 onward.

[9] C. Still, Recklinghausen, Germany. E.P. 28,072/1912, 28,245/1913, 147,736/1920.

[10] F. H. Wagner. The Bartlett-Hayward Company, Baltimore, U.S.A. "Coal Gas Residuals," the M'Graw-Hill Book Co.

[11] F. C. Briggs, Dudley Gas Company. Presidential address; Midland Assocn. of Gas Engrs. and Managers, March 11, 1926. "GAS JOURNAL" for March 17, 1926.

[12] F. H. Clayton and F. W. Skirrow. "GAS JOURNAL," June 4, 1907.

[13] N. W. Sultzer. "Gas Age Record," April 14, 1928.

flow, though not necessarily in proportion to the original ammonia content.

LIQUOR STRENGTHS ATTAINABLE.

If the yield of gas in the above cases is taken at 13,000 c.ft. per ton, it will generally result that about 8 galls. of water per 10,000 c.ft., or say 10 galls. of water per ton of coal, will be demanded by the washing plant. Hence our ammonia liquors will ultimately leave the plant at an average strength of 2·1 p.ct. to 1·2 p.ct.

The above figures are probably representative, but cases arise outside these limits. The usual exceptions are works employing vertical retorts where heavy steaming is practised and a large proportion of steam is passing undecomposed. Such conditions may clearly set up a somewhat high temperature in the washing plant if the condensers are not fully adequate; and to carry out a high proportion of removal in the washer will require a larger flow of clean water, and the final liquor strength is thus impaired by both these conditions.

It is claimed that the practice of steaming gives a higher yield of ammonia from the coal, but this higher yield does not seem to be in anything like the proportion of dilution set up by the steaming. It follows, therefore, that the liquors from steamed retorts are usually weaker than those from other carbonizing systems, in spite of a higher total yield.

The proposals of Cobb and Marson[14] to carry out carbonization and steaming of coals treated with alkalis may become of interest in this connection, as they find that the coke becomes highly reactive to steam, and the undecomposed proportion of the steam is remarkably low. The study of blending and other means of increasing the reactivity of coke is already producing some results in this direction.

The dilution of the ammonia liquor results in increased steam consumption for the subsequent distillation on the ammonia plant.

The matter of the gross volume of the effluent from the ammonia plant, and the total quantity of toxic substances therein, is also important as dictating that attention should be given to keeping down the quantity of steam in the gas leaving the retort.

AMMONIA ABSORPTION FROM CRUDE GAS.

The absorption of ammonia in water in the washers does not quite follow the simple laws usually assumed when treating absorption from a theoretical point of view. The presence of CO_2 and H_2S influences the course of events fundamentally. Speaking broadly, a washer wherein clean water is brought into contact with the stream of crude gas in counter-current, will show characteristics indicating that the conditions at the water inlet end approximate to those of the removal of ammonia in the absence of the acid gases, though these are present; and that these conditions merge almost immediately into those expected in the presence of the acid gases. The partial pressure of a fairly strong gas liquor is about one-ninth of that of an equivalent solution of ammonium hydrate, and this difference is what is reflected in the state of affairs described.

Fig. 3 shows values taken from actual tests, and is typical of this particular reaction. The ordinates show the building-up of ammonia concentration in the different steps of the mechanical washer. In the larger right-hand area, the curve approximates closely to a geometrical progression (which is shown by the line which represents the sums of calculated geometrical series), but in the left-hand area, where the liquor strengths are low—that is, at the water inlet—a departure is found in a direction which shows at first a slower building-up—that is, a higher partial pressure of the dissolved ammonia. It should be added that where the acid gases are entirely absent throughout, the steps work out very accurately on the lines of a geometrical progression.

SYSTEMS OF WASHING.

In Europe, gas-works practice has consistently followed the lines of the various types of mechanical washer, which are alike in that they employ a general counter-current principle, but incorporate a number of single contacts which individually are not of a counter-current mechanism. American works have washers of these types, but there has been a considerable turnover to a multiple series of tower scrubbers. These are the same apparatus as the washer-coolers previously described, but without the external cooling coils. There have been developments in Europe recently on these lines,[15] but at the time of writing nothing has appeared to show whether they represent any advance in technique.

Any of these systems may be found associated with the Livesey type washer, which we have mentioned in its function as a tar extractor. It is common practice to feed this washer with the strong liquor from the ammonia washer in counter-current with the gas.

The success of the mechanical washer is found in that the accurate distribution of the gas and liquid streams is guaranteed by the controlled movement of the washing surface as well as by the actual construction of the apparatus. Comparing this with a single tower scrubber, the latter depends primarily on its structure only, and the forces of gravity procure the necessary movement. The mechanical washer has in this the advantage, whereas its disadvantage theoretically lies in that it can have only a finite number of steps. This disadvantage is, as we shall see, only apparent—that is, as compared with the single tower scrubber which, according to current theory, should be free from such a limitation.

The multiple series of towers mentioned above has the same characteristics as the mechanical washer, in that each contact is carried out with disregard of strict counter-current (a rapid recirculation of liquid is maintained through each tower, while a properly proportioned feed of water is given to that tower in which the gas is treated last; an intermediate receiving tank overflows, in virtue of this feed, into the next stronger). Usually, by means of a centrally placed vertical partition, the gas and liquid are made to descend together in half of the scrubbers, and in the other half the gas ascends; an obvious convenience of construction.

This washing apparatus, therefore, seeks the positiveness of distribution given by the rotary types, along with the cheapness and simplicity of tower fillings as contact surface. In actual fact it is usual to have only four to eight individual contacts, whereas the rotary machines commonly have from eight to twelve, or even more.

LIMITS OF PERFORMANCE.

The importance of these considerations lies in this, that the process of washing gas free from ammonia with water is probably the most exacting demand of washing apparatus in gas-works to-day. The highest efficiency is demanded because a large proportion of removal (often 98 to 99 p.ct.) is required,

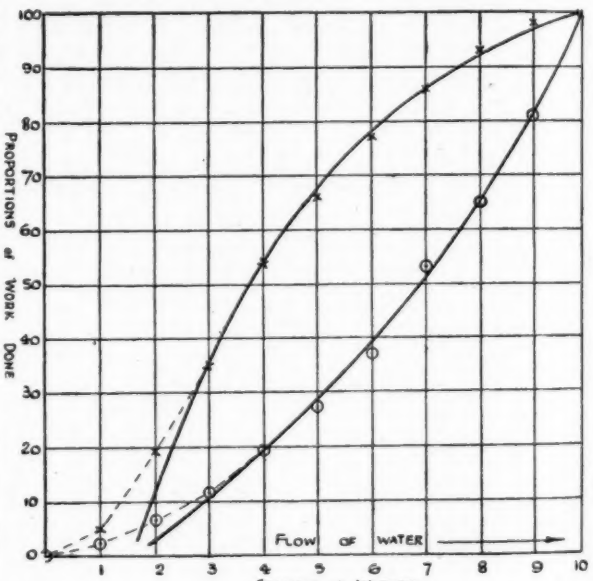

Fig. 3.

The points indicated are actual concentrations of ammonia in the liquors in successive sections of a mechanical washer, represented as proportions of the concentration finally attained. In the higher range a geometrical progression is approximated to, and the lines are drawn through the points representing such progressions.

along with the maximum concentration of the wash liquid. Using the parallel often drawn between gas washing and heat exchange, it is equivalent to the demand that a hot fluid should be cooled within a fraction of a degree of the cooling means, using for the purpose the minimum flow of the latter.

The simplest way of perceiving the point at issue is to consider that in a sectional contact apparatus, such as the rotary washer, the gas is finally treated, not with the pure wash-liquid (in this case clean water), but with the product of reaction in the last contact chamber, at the maximum concentration which it can attain in that chamber. Obviously, therefore, there is an advantage in dividing the available washing surface into as many separate contact chambers as possible, while maintaining strict counter-current flow in the series.

A full theoretical examination of this question is not possible in the present circumstances, but an illustration of the point is given in the Third Report of the Research Committee of the National Benzole Association of Great Britain, p. 147. A paper by Masson and McEwan also deals with this and kindred matters.[16]

It was mentioned that the single tower scrubber is usually regarded as independent of any such considerations. According to the writer's view, however, this is hardly the case. The formulæ usually employed to show the properties of these

[14] C. B. Marson and J. W. Cobb, University of Leeds. Gas Fellowship Reports to The Institution of Gas Engineers, 1925-26.

[15] R. Miles. Newton Chambers & Co., Ltd., Sheffield. "GAS JOURNAL," May 2, 1928.

[16] J.S.C.I., 1921, 32 T.

scrubbers, such as that of Donnan and Masson,[17] are strictly parallel to the general formula for heat-exchange apparatus,[18] and are really independent of any relative dimensions such as height and diameter. A velocity coefficient may be incorporated, but this is not quite the same thing.

Tower Scrubbers.

It is possible to regard a tower scrubber on the same lines as a sectional scrubber; that is, as a series of contact vessels between which counter-current exists, but within each contact strict counter-current is departed from. Any section of a perfect tower scrubber should have the property that the ultimate possible transfer in an infinite time of passage is represented by an exact exchange of the extreme concentrations for one of the streams. This property depends on the distribution and the tower filling being perfectly uniform and homogeneous.

A more or less consistent departure from such perfection may be assumed for a practical construction. Thus an actual tower can be imagined as made up of a series of sections of reduced height-diameter ratio, in each of which the falling away from exact conditions is represented as equivalent to the by-passing out of contact of a certain proportion of the liquid flow. A good filling would achieve such a standard with a small height-diameter ratio, and a less efficient one would demand a larger ratio.

Consequently there is here an indication of the necessity for a larger height-diameter ratio for the poorer grades of filling materials. The tower must have not less than a certain number of sections, each of the required standard, in order to make the best use of the contact area it contains.

This leads to two conclusions which are parallel with the known properties of sectional contact apparatus. For any specified service there is a minimum value of n, the number of separate contacts, and there is also a value of n beyond which the advantage of division practically disappears; and the cost of the apparatus will generally rise as the value of n is increased.

(When increasing the value of n it is assumed that the total surface of contact is held constant. The increase in value of n is obtained, of course, by raising the height-diameter ratio, which makes possible the regarding of the tower as made up of more sections each of the standard property in respect of distribution.)

Entrainment of wash liquid in the gas is also found to have an effect equivalent to the diminution of the effective number of contact sections. This effect of entrainment, in limiting the capacity of counter-current apparatus for washing and distilling, is frequently attributed to other circumstances, and is, in the author's opinion, present in many cases where it is not suspected.

In connection with the general theory of counter-current washing, it may be noted that the main considerations governing the use of towers in series are dealt with in a paper by Still.[19] It is shown that the capacity of the installation is at the maximum when exact counter-current holds throughout the series. In practice each tower is given a larger flow of liquid, by recirculating, than is actually demanded. Obviously this must be done to overcome the faults of distribution which would show more definitely if the minimum flow, equal to the liquid input, were alone circulated. This paper is worked out as for benzole removal, but applies equally to any series of towers, such as the intensive scrubbers of American practice.

Washers.

The mechanical washers in common use are of two main types. The horizontal rotary machine has a mass of contact surfaces mounted on a rotating shaft which causes the washing surface to be continually re-wetted before presentation to the gas. This apparatus is, for a given service, high in first cost, but if well designed and constructed will compensate for this by long life and low upkeep charges.

The various centrifugal washing machines create a series of contacts in separated chambers by projecting quantities of the wash liquid to spray through the gas stream. The sprayed liquid returns to the same tray from which it was drawn, and the appropriate rate of counter-current flow goes on by gravity, independently of this mechanical movement.

In the design of such machines two facts of importance have to be kept in mind. The limitation imposed by the necessarily finite number of contacts operates even if the extent of the surface be enormously increased. Therefore, there is an economic limit to the amount of such surface which need be created. Further, there is the disadvantage of entrainment if the sprays be of too fine a character. Any carrying-over of spray with the gas reduces the efficiency, which can only be met by an increase in the wash-liquid, which is undesirable.

Washing by Acids.

The retaining of volume of ammonia liquors at the lowest practicable figure being found to be so important in the economy of gas-works, it is not surprising that attempts have been made to eliminate the final washing process in various ways. These have generally taken the form of converting into sulphate the ammonia not absorbed into the water of condensation. The general type of such plant is found in its complete form in the semi-direct system of recovery on coke plant, used by Koppers originally. This recovery method has apparently not been applied hitherto in gas-works using other than oven benches.[20]

A large works in this country will, however, shortly come into operation, where mixed horizontal and vertical retort gases will be treated on the semi-direct system. Another system, however, is in successful operation at various works wherein the cooled condenser liquor is brought into contact with the gas after cooling and tar extraction, thus ensuring that the maximum absorption has taken place into such liquor, and thereafter the gas is washed free of ammonia by bubbling through sulphuric acid (admixed, of course, with water and ammonium sulphate). Early plants on these lines seem to have had but moderate results, but recent surveys on two fairly large installations[21] show that there is no reason why success should not be attained.

Some water is likely to be contributed, particularly in cold weather, from the gas by condensation and absorption. In such weather, it may be noted, the ammonia content of the gas will be below the average.

It was formerly reported that the gas which had been so treated was liable to create difficulties in oxide purifiers, as a result of entrainment of acid. These reports appear to apply to some small and early plants, and it does not appear to occur in later ones. It should be noted that the operators of these plants find it possible and advisable to allow a trace of ammonia to pass the washer, to maintain the maximum activity in the purifiers.

The advantages of working with the acid catch are appreciable; but too much must not be expected. The full advantages are, of course, only possible to works which possess a sulphate of ammonia plant. In view of the general tendency for bye-product sulphate to become unremunerative, and of the possibility that centralized treatment of ammonia liquors may shortly be the only means of combating this tendency, the opportunities for the wide adoption of acid treatment may disappear.

Gas Drying

The first proposal to distribute coal gas in a dehydrated state appears to have come from Lucien Brémond, of the Versailles Gas-Works; and his objects and methods can be read in E.P. 997 of 1877. The only advantage desired was to inhibit the deposition of naphthalene, which it is positively stated is to be procured by dehydration. Brémond, according to this specification, demands dehydration "to the utmost;" and the reason for this would appear from an article published in the "Journal du Gaz et de L'Electricité," which was abstracted in the "Gas World" of 1888.[22] Brémond here states that naphthalene can be produced in the gas after leaving the purifiers, by interaction between water vapour and other gas constituents in the cold. In consequence of this somewhat unorthodox view he must have complete dehydration, and therefore cites only such agents whether liquid or solid, for dehydrating as will give complete dehydration.

Later, dehydration of air for furnaces (*e.g.*, blast furnaces) was proposed by various means, including most of the practicable methods. The importance of dehydration of air in the blast furnace is to prevent the formation of water gas, which reaction, by absorbing heat, reduces the temperature in the furnace measurably, and cuts down output more than in proportion to this heat.

Mention has more than once been made in the Technical Press of the superior condition of dry meters used on natural gas, which is distributed dry on account of its having been released from pressure in the oil measures; and it was suggested that means would be found in the future to procure this condition in manufactured gas.

Moisture in distributed gas appears to require at least two conditions in order to appear as a harmful impurity. These two conditions are that at some point it should be condensed to the liquid state, and that there should be some oxygen present at the same time. It is doubtful whether other agents which have been cited are effective in the absence of these conditions. Experiments conducted by the author and others[23] [24] tend to this view.

At a point nearing saturation there is slight attack on iron, in the apparent absence of liquid deposits, but it is probable that there is an absorbed film of water in these circumstances, which is not perceptible by ordinary means. The rate of corro-

[17] J.S.C.I., 1920, 236 T. Also: J. Brown. J.S.C.I., 1925, 410 T.
[18] Van Arsdel. "Chem. and Met. Eng.," 1920, p. 1115.
[19] C. Still. "Gluckauf," 1908-9. Reprinted by Coke and Gas Ovens, Ltd., and by the Coke Oven Mgrs. Assocn. Year-Book, 1920.
[20] L. H. Sensicle, Newcastle-upon-Tyne and Gateshead Gas Company, "Gas Journal," May 9, 1928.
[21] These installations are at the gas-works at Stockport and at Pitwines (Bournemouth).
[22] Vol. 8, p. 11.
[23] E. Ott and F. Hinden. Monats-Bulletin Schweizer V. Gas Wasserfach, 1927, Nos. 1-2.
[24] F. C. Smith, Gas Light and Coke Company. "Gas Journal," April 11, 1928.

sion was in one case, employing gas at about 90 p.ct. saturation, estimated to be of the order of one-hundredth of the rate found with the same gas under conditions of complete saturation—*i.e.*, with a perceptible deposit of water present.

It appears, therefore, that the important requirement is that gas being distributed should be so far dehydrated that it will be free from the possibility of further condensation throughout its journey to the point of consumption. The climatic conditions chiefly will dictate what margin should be allowed. Statistics are not available for more than one or two regions, but so far it appears that a proportion of removal of 50 to 60 p.ct. will cover most demands in this respect.

This aspect of the question has been reviewed by Harris[25] in the first description of actual operation of a plant for water removal from gas. Previous to this a comprehensive examination of the possibilities of various methods of dehydration of gas was made by Sperr,[26] including four groups : Compression, refrigeration, chemical and physical absorption, and adsorption. It is clear that, in the absence of some special circumstances, each of these represents the necessity of a cyclic process. This appears most clearly in the case of the refrigeration method; and the power demand of the compression method could be brought into line with this statement. The absorption and adsorption processes employ a reagent which has to be regenerated (or removed entirely from the system, which would make one of the special circumstances just mentioned).

In the case of the compression and refrigeration processes it is easily seen to be true that the further the process is carried, the more expensive it becomes, particularly when compared with the diminishing quantities of water removed. The same is true of the absorption and adsorption, where, for example, the regeneration is carried out by re-evaporation of the diluted agent. This consideration destroys any distinction between agents such as sulphuric acid, silica gel, &c., which can give substantially complete removal if desired, and the agents such as salt and other solutions, which are applicable up to a certain proportionate removal only, if the desirable and economic limit of dehydration is within the field of the latter.

This condition appears to be existent, and the choice of an agent will probably depend on other characteristics than the ultimate possibilities of the substance. Some other results of this conclusion will appear later.

Compression.

Power cost will be the primary consideration in the question of whether to compress, and how far. To create a sufficient margin of dehydration, a pressure of (say) 30 lbs. gauge will be required, and immediate cooling of the gas to retain the water at the point of compression. The power consumption can be estimated at 80 H.P. per million c.ft. treated, and the water for cooling at 20,000 galls. per million c.ft.

Installation cost is to be reckoned high in comparison with other methods, even when distribution is effected at a pressure approaching that of the dehydration apparatus. In fact, in such cases, it would probably be preferred to have a duplicate compressor for stand-by. If distribution at low pressure is intended, it would be possible to recover some of the power cost by causing the re-expansion to do work. This would again imply a higher first cost.

Reference should be made to the report on " Dust and Moisture Control " to the Pacific Coast Gas Association, 34th Annual Meeting.[27]

Compression plant would presumably require continuous supervision, on the lines of exhausting plant, and would have to register accurately therewith, or with the momentary rate of consumption. No particular difficulties seem likely to arise in this respect.

Refrigeration.

The refrigeration method starts out with the handicap that the whole mass of the gas has to be cooled, a heat load being thus incurred which cannot be turned to useful account, unless it is through heat exchange with the incoming gas. With certain grades of gas, undesirable deposition of bodies other than water is likely to occur; and if cooling below 32° Fahr. were practised, trouble with solidification of ice would arise.

Actual proposals[28] appear to have been made to limit the treatment to washing gas with refrigerated water, which obviates the last possibility. It does not appear to the writer that a sufficient dehydrating effect can be hoped for by such means. The minimum temperature of the water is above its freezing-point by a considerable margin; a further margin is necessarily implied between this temperature and the dew-point of the treated gas; and (in the apparatus actually proposed, which employs atomizing sprays to effect the contact) any entrainment effects will give a further step away from the minimum. With all these margins it is estimated that the best result possible is a dew-point of 40° Fahr. In the article by Bragg it is stated that this should be sufficient; but it is difficult to believe that this statement will be justified. Even in England, where conditions are, relatively, equable and mild, the writer has found gas leaving holders at 35° Fahr. over long periods, and has received reports of frozen service pipes, chiefly on street lighting.

In countries where underground mains have been found frozen, the safe dew-point must be very low at times. In this country, at any rate, it would be a doubtful and difficult proposition to put before the medium and small works, as the plant would require a class of supervision which could not readily be accorded, at least without a special and large charge. This would be particularly observed, as against the result achievable, and in comparison with other possible processes. The necessity of dealing with deposits of naphthalene and other hydrocarbons would doubtless vary at different works, but, except so far as the former was removed, would not add to the attractiveness of the process.

Absorption and Adsorption Processes.

It is clear, in considering the compression and refrigeration proposals, that the main matter is how far to carry the intensity of the treatment, and the cost incurred at the stage chosen. Exactly parallel considerations apply to most of the possible treatments which come under the above heads. So far, the agents which appear to have been proposed for the actual dehydration of the gas are: Saturated solutions of salts (*e.g.*, calcium chloride) as in the process described by Harris;[25] solid reagents (*e.g.*, lime, calcium chloride); sulphuric acid; phosphoric acid; glycerin; and silica gel.

Reports are available at the present moment only on the first of these proposals, which has been adopted in about twenty works, all in Great Britain.

The theory can be applied to all these possible processes in the following manner. In all cases, except perhaps where sulphuric acid is proposed, the necessity of regeneration has to be considered. Consequently, whatever fraction of the saturation pressure of water is to be the object of the process, the reagent, diluted below the concentration appropriate to give this result, has to be brought back to a state of useful concentration. The maximum effect is, therefore, regulated, among other factors, by this: The absorbed water must be expelled from the reagent, which is such that it has always a vapour pressure only a fraction of the saturation pressure of water. Thus it will be seen that the higher proportions of water vapour removal from the gas, if desired, will always demand a more rigorous after-treatment of the absorbent, and the extra removal in the absorber will be progressively more slender as the regeneration of the absorbent becomes more difficult.

The second important circumstance to note is that there is in every case a heat evolution more or less proportional to the quantity of water absorbed (*i.e.*, brought into the liquid or solid state). The re-acting vessel, therefore, tends to suffer a rise in temperature. Such a rise, by raising the vapour pressure of the absorbent, reduces the power of absorption of the reagent, which power is necessarily proportional to the difference of vapour pressures between the gas and the reagent. The latter can conceivably be such that the effect of such a temperature rise will be negligible (as in the case of strong sulphuric acid, or silica gel in a highly active condition), but the continued repetition of the action in a cyclic process depends, as we have seen, on the possibility of regeneration.

It has been proposed[26] to employ sulphuric acid at a suitable concentration, and after dilution to transfer it to a sulphate of ammonia plant. Whether this process can be used without ill effects on the gas, the writer is not prepared to say, but its adoption presupposes the existence of the sulphate plant, and a duplicate acid storage; or alternatively a buyer for the acid after its absorption of water and any other impurities it may have acquired. Another important objection is that it is by no means certain that a sulphate plant will take care of the additional water thus introduced into the saturator. The problem then becomes again one of evaporation.

Reverting to the temperature rise, which can be easily and accurately calculated from the moisture absorbed, with careful note that as the temperature rises the absorption progressively decreases, and with one or two minor corrections on the lines of heats of dilution, we may note here that, with uncontrolled rise of temperature, an absorbent capable, according to its measured vapour pressure, of reducing the moisture content of the gas to one-tenth of the saturation pressure will, if applied to gas at 70° Fahr., cause a rise to about 108° Fahr., with the result that only 64 p.ct. of the water content of the gas, entering saturated at 70°, will be removed. This result could be equally well achieved by using an absorbent with power to take up exactly 64 p.ct., and controlling the temperature so that the final contact of the gas with the fresh reagent was at a temperature no higher than the original.

These conditions are fulfilled by the process quoted as in use in this country, and which has now, on one works, been successfully operated for two years.[25] The results, as regards maintaining a water-free distributing system, have been realized throughout, and the cost, which, though the works in question is of only approximately 1 million c.ft. per day maximum out-

[25] C. Harris, Gas Company, Taunton, England. "GAS JOURNAL," Nov. 23, 1927.

[26] F. W. Sperr, Jr., Koppers Co., Pittsburgh, U.S.A. A.G.A.—1926 Convention.

[27] "Gas Age Record," Nov. 26, 1927, p. 811.

[28] G. A. Bragg. "Gas Age Record," Feb. 4, 1928.

put, is under 0·25d. per 1000 c.ft. treated, has been much more than repaid by the cessation of complaints, and the progressive reduction in rate of degradation of dry meters. The life of iron parts in the pipes and services cannot, of course, be said to be known under the new conditions, but there is clearly good reason to hope that, internally, their condition will remain unimpaired. Direct experiment, so far, is confirmatory.

The proportion of removal which has given these results is about 60 p.ct. from the saturation pressure, and is obtained by the use of calcium chloride solution as the absorbing agent. In our climate, at any rate, there would not seem to be any necessity for going beyond this proportion.[29] This conclusion is supported by similar results on other installations, including one which operates at the outlet of the gasholder[30] at the rate of consumption; and by a study of such data on relative ground and air temperatures as are available. It should be borne in mind that such an absorption process gives a progressively lower dew-point according to the temperature at which the gas enters, and also according to that of the cooling water available. Thus it works generally in sympathy with all the broader climatic variations, and there is found to be a margin of safety to cover the temporary and accidental variations.

The following comparison of proposed absorbents may be made:

SULPHURIC ACID: Cheap and effective. Requires special plant. Regeneration not advised, preferably used for other purposes. Possible reactions with gas constituents.

SOLIDS: Calcium chloride. Silica gel. Difficult to handle in cyclic manner, and would be to regenerate *in situ*, making intermittent process. Calcium chloride has possibility of liquefying. Silica gel capable of various secondary reactions and not unlikely to lose activity. Cooling of reaction bed very difficult, therefore reagent must be highly absorbent; this implies exacting regeneration stage.

SALT SOLUTIONS: (Calcium chloride). Limited to absorption of about 65 p.ct. unless cooling conditions better than normal. Cheap, and easily obtained. Solution high in water content, regeneration very flexible. Viscosity low, good condition for absorption and heat transfer. Non-corrosive as thus used. Other salt solutions correspond in varying degrees.

GLYCERIN: Fluid at all concentrations, but highly viscous in effective range for dehydration. Range of compositions available very limited, therefore regeneration exacting, particularly if process attempted without cooling. High viscosity causes low transfer coefficients in absorption and cooling. Slightly volatile. Relatively expensive.

The following are representative costs for the compression, refrigeration, and absorption processes. They are based on installations of one million c.ft. per day maximum capacity, and a humidity of 40 p.ct. in the treated gas is assumed. (The refrigeration plant, however, as pointed out, will not give this result except when handling gas at fairly high initial temperatures.)

—	Compression.	Refrigeration.	Absorption by Calcium Chloride.
Cost of plant, foundations, &c. (no duplication of equipment allowed for)	£1600	£1400	£1500
Power consumption, KW. . . .	60	10	2·5
Water consumption per million c.ft.	20,000 galls.	4000 galls.	9000 galls.

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[29] A. Marsden, Bristol Gas Company. Pres. Address: Western Jun. Gas Association, April 14, 1928. "GAS JOURNAL," Vol. 182, p. 248.

[30] Inst. of Gas Engineers. "GAS JOURNAL," April 11, 1928.

Some Technical and Economic Aspects of the Bye-Product Ammonia Recovery Problem.

By P. PARRISH.

Authoritative Body: The Joint Fuel Committee of The Institution of Gas Engineers, the Society of Chemical Industry, the Coke Oven Managers' Association, and the Institute of Fuel.

No one denies that the manufacture of ammonium compounds from bye-product ammonia on an economic basis constitutes a distinct problem at the present time. The progressive increase in the production of ammonium sulphate manufactured from synthetic ammonia, and the consequent fall in selling price, makes the problem more acute. An indication of the gravity of the situation is afforded by the recollection that fifteen years ago the realization by many gas undertakings by the recovery of ammonia and its conversion to sulphate of ammonia or other ammonium salts represented 15 to 20 p.ct. of the cost of the coal. To-day the larger gas undertakings deem themselves fortunate if their revenue for bye-product ammonia covers 5 p.ct. of the cost of the coal. These conditions, in a measure, apply to coke ovens.

The cost of recovering bye-product ammonia to-day at many medium and small gas udertakings ranges from 6d. to 1s. 6d. per ton of coal carbonized. The question arises at once: Why should it cost more to recover and subsequently release ammonia from gas liquor than it does to produce ammonia by a complicated process, involving expensive plant? It is not proposed to give a direct answer to this question, but rather to examine one or two technical and economic aspects which must, at least, afford some information relative to the question propounded.

One outstanding factor cannot be ignored. This relates to the magnitude of the manufacturing operations as the synthetic ammonia works at Billingham. It has been announced that they hope to complete their programme by 1930, when the total output of ammonium products will be equivalent to 2100 tons of sulphate per day, or over 750,000 tons per year. Even assuming this programme is not realized, and that, in view of Lord Melchett's declaration at the Adriatic Conference, the eventual output will be 1000 tons per day, or 360,000 tons per year, it is a stupendous quantity. It is known that the largest works producing ammonium sulphate from bye-product ammonia does not exceed 25,000 tons per year.

It is recognized that gas for power, lighting and heating is the primary product of gas undertakings, and that the recovery of ammonia is a secondary consideration. Similarly, in the case of coke oven plants, coke is the primary product, and the recovery of ammonia is a less important consideration. Ammonia, however, must be recovered, whether gas or coke is the primary product, and, dependent on the nature and efficiency of the recovery process, a revenue or a loss of some significance may be incurred.

Many agree that there are far too many gas-works carbonizing coal to-day. It is true that the cost of the transmission of gas is an important item in the selling price of coal gas. Even so, it cannot be doubted that carbonization could be concentrated at a number of points with advantageous results. Any such concentration would be a step in the right direction in mitigating the gravity of the bye-product ammonia recovery problem. Despite any such centralization of carbonization as is foreshadowed, the belief is held that the recovery of ammonia at the majority of works should only proceed to a certain point, and that its final treatment should be carried out at a number of centrally-situated chemical works.

At such works spent oxide should be converted into sulphuric acid, and the ammoniacal intermediate products should undergo treatment in the manufacture of final ammonium products. What the situation of these works should be, and how many carbonizing undertakings they should embrace, need to be viewed from both the technical and the economic aspects. What is involved will be discussed later.

During the last twelve months many suggestions have been offered as a partial or complete solution of the problem in question. Some refer to the method by which the ammonia is recovered; others relate to the utilization of anhydrite in lieu of sulphuric acid in the manufacture of ammonium sulphate.

Some (and among these is Mr. L. H. Sensicle, *vide* "GAS JOURNAL," Vol. 182, pp. 384-391) think that the problem can be solved by adopting the direct process for the recovery of ammonia as ammonium sulphate, on the lines conducted at some of the coke oven plants to-day. Others think that concentrated gas liquor should be produced and sent to a centrally-situated works for treatment; others think this intermediate product should take the form of concentrated ammonia liquor; and there are some, among whom the writer is one, who think that the ammonia should be recovered at gas-works in the form of ammonium sulphate solution containing 40 p.ct. $(NH_4)_2SO_4$, and that this should be sent to centrally-situated works for conversion into ammonium sulphate of uniform quality and special crystal size.

It will be well to review briefly these suggestions, in order that a complete picture of the problem of bye-product ammonia recovery can be correctly envisaged.

1. In the writer's view there is no such thing as a direct

process of sulphate of ammonia manufacture. It is true that coke-oven recovery plants are said to operate the direct process, but the last-named is more imaginary than real. A salient feature of the so-called direct process is the avoidance of any condensation prior to the absorption of ammonia in sulphuric acid. If one succeeds, ammonium chloride is usually carried to the saturator, and this apparatus and the mains leading from it must suffer from corrosion by hydrochloric acid, due to the dissociation of ammonium chloride.

Efforts to overcome corrosion by spraying tar, creosote, or water, to remove ammonium chloride, have not proved too successful. With a spray of the type indicated, a thick, viscous, tarry mass containing ammonium chloride is produced. The has to be treated in a suitable way, for the recovery of muriate of ammonia, which is impure, and for which there is only a limited sale at a very low price.

It is known that the quantity of devil water condensed after the saturator is not inappreciable, and that it possesses toxic properties. Many determinations with average coal, as carbonized at gas-works, have been made, and it is known that (*a*) about 16 gallons of water per ton of coal carbonized is due to the coal substance itself. In addition to this, the water (*b*) introduced *via* the 70 p.ct. sulphuric acid has to be evaporated, and/or entrained, and this amounts to 80 gallons per ton of sulphate of ammonia (25·7 p.ct. NH_3), made; or, assuming a recovery of 28 lbs. of sulphate of ammonia per ton of coal carbonized, one gallon of water per ton of coal treated.

Where 80 p.ct. sulphuric acid is used, about 47 gallons of water have to be evaporated and/or entrained, representing on the former basis 0·6 gallon per ton of coal carbonized. Further, 15 to 20 gallons of wash water per ton of sulphate of ammonia manufactured have to be introduced to the saturator, to maintain the centrifugal in a satisfactory condition for operation.

If the direct ammonia recovery process were installed at gas-works where steaming is the vogue, the quantity of water may well increase to a very sensible extent, from (say) 20 to 30 gallons, or more, per ton of coal carbonized. Moreover, the quantity of tar is not nearly so satisfactory as that yielded by the semi-direct or indirect processes. In some cases it resembles pitch rather than tar.

It would appear that the so-called direct process is unsuitable for application to gas-works, if for no other reasons than those stated above.

The semi-direct process is the one favoured by most chemical engineers and coke-oven managers in this country. It aims at reducing the production of gas liquor to a minimum. Its application to gas-works practice would introduce defects which cannot be ignored. Among these, mention may be made of the following:

(*a*) Dilution of the bath by the water vapour resulting from the condensation of steam from the steam-ammonia stream constitutes a disability which must inevitably occasion loss by reason of the production of redundant mother liquor.

(*b*) The reduced solubility of ammonium sulphate in the saturator liquor, due to the bath being operated at a temperature of 40° to 46° C., would lead to the use of an intermittent feed of acid, with the result (1) that tarry matter would be arrested in such a form as to constitute a nuisance, and (2) sulphate of ammonia in the form of a powder of an indifferent colour would be produced.

It is true that steps could be taken to reduce or circumvent these difficulties. It is known that Koppers pre-heat the gases leading to the saturator, and that the Semet-Solvay Company provide a dephlegmator, with a view to removing water vapour, so as to avoid diluting the bath. Despite these provisions, which have certainly helped to make the process more satisfactory, it cannot be said that the sulphate of ammonia produced is altogether satisfactory in point of crystal size.

What are the alternatives to the process already briefly discussed? They would appear to be these:

(*a*) Gas-works could still continue to recover ammonia as gas liquor, as obtains to-day, but instead of distilling the ammoniacal liquor for the manufacture of sulphate of ammonia, it would be possible, by a slight modification of the sulphate of ammonia plant, to produce concentrated gas liquor. This product could be sent to a centrally-situated works, at a reasonable cost as regards transport, for conversion to suitable ammonium products, or

(*b*) Steps could be taken to recover the ammonia as a solution of ammonium sulphate, containing 40 p.ct. $(NH_4)_2SO_4$.

It will be well to examine what is involved in connection with the two processes in question.

Process (*a*): *Concentrated Gas Liquor.*

It is certain that at many works it will be profitable to concentrate gas liquor, rather than send it, containing about 2 p.ct. of ammonia, to chemical works at some distance, and then be called upon to pay for its removal An example can be cited by the author from personal experience, which is undoubtedly typical of many cases at other gas-works. The works in question carbonize 5000 tons of coal per year and produce 400 tons of gas liquor of 11-oz. strength. At present, the gas company is paying 4s. per ton for the removal of the ammoniacal liquor from its works. At a cost of £500 it would be possible to erect plant capable of distilling one ton of gas liquor per hour, and producing concentrated gas liquor of 15 p.ct. NH_3 content. The cost of concentrating 400 tons of gas liquor in a 1 ton per hour ammonia still at such works would be approximately as follows:

	£	s.	d.
1. Labour $\frac{400 \text{ tons}}{24 \text{ hours}}$ = 16 days' wages; three shifts per 24-hour day = 48 shifts at 10s. 6d. per shift . . .	25	4	0
2. Steam for distillation, based on 30 lbs. per 100 lbs. of gas liquor = 120 tons at 3s. per ton	18	0	0
3. Cooling water and repairs and maintenance . . .	5	0	0
4. Interest on capital and depreciation on plant, at (say) 10 p.ct. per annum on £500	50	0	0
	£98	4	0

For such concentrated gas liquor it would be possible to pay, based on present market prices for sulphate of ammonia, for agricultural purposes, 7s. per ton, delivered into tank wagons f.o.r. at the gas-works.

Thus, the realization for concentrated gas liquor would be (*a*):

	£	s.	d.
400 tons of gas liquor at 11 oz. strength would yield $\frac{400 \times 11 \text{ oz.}}{69 \text{ oz.}}$ = (say) 63¾ tons of concentrated gas liquor (15 p.ct. NH_3 content) at 7s. per ton . . .	22	6	3
(*b*) In addition to the above realization, the gas undertaking would not have to bear the debit of 4s. per ton on gas liquor of 11-oz. strength. Therefore, 400 tons at 4s. per ton	80	0	0
	£102	6	3
Thus, the economy effected by the installation of plant for the production of concentrated gas liquor would be.	£4	2	3

Although this saving is small, it is certain that it is in the right direction. The above example concerns a gas-works about twenty-five miles from the chemical works which treats the gas liquor. Of course, the greater the distance of a gas-works from the ammonia works, the more profitable is the concentration of gas liquor likely to prove.

So far as medium-sized works are concerned, what is necessary in their case is the installation of a reasonably large unit of distillation plant. Labour constitutes an important item in the cost of concentrated gas liquor. Similarly, steam, lime, and depreciation represent important items.

Generally speaking, each works must decide for itself whether the manufacture of ammonium sulphate or the production of concentrated gas liquor, or the sale of gas liquor as such, or the production of ammonium sulphate solution, is the better proposition.

Process (*b*): *Ammonium Sulphate Solution.*

It is known that there is no technical difficulty in the recovery of 45 p.ct. of the total ammonia produced in the straight carbonization of coal as ammonium sulphate solution containing 40 p.ct. $(NH_4)_2SO_4$. Indeed, the whole of the ammonia can be so recovered, provided the virgin gas liquor is distilled, and suitably arrested in sulphuric acid.

Where a gas-works is situated in close proximity to the sulphuric acid works, having ammonium sulphate plant, there can be no doubt that this process is likely to prove attractive, as the recovery of ammonia resulting from the carbonization of coal as ammonium sulphate solution, 40 p.ct. $(NH_4)_2SO_4$ content, need be no more expensive than the production of gas liquor. That it is a much more valuable product goes without saying.

It is true that in any such process extra work is thrown on the oxide of iron purifiers, which may be called upon to remove an additional 10 p.ct. of hydrogen sulphide. This need not, however, constitute any serious disadvantage. What is somewhat more serious is that the carbon dioxide content of the gas is likely to be increased by 0·5 p.ct., and this will affect the flame temperature to such a degree as to warrant the consideration of means for eliminating the CO_2 content of the gas by an alkaline solution after the sulphuric acid special absorber.

The plant for the treatment of ammonium sulphate solution, 40 p.ct. $(NH_4)_2SO_4$ content, in the production of crystalline ammonium sulphate, is simple to operate, and not unduly expensive as regards capital cost. Moreover, a very attractive product can be produced from the viewpoint of crystal size and character, as well as from the aspects of colour and neutrality.

Where the gas-works is situated some distance—say, more than 25 miles—from a chemical works, then the cost of the carriage on sulphuric acid (namely, about one ton per ton of ammonium sulphate) and the removal of 2½ tons of ammonium sulphate solution (40 p.ct. $(NH_4)_2SO_4$ content) per ton of sulphate render this method of operation less attractive than process (*a*), to which attention has already been directed.

Other methods are available for the utilization of gas liquor, but it is impossible to deal with these in the limited time available.

Process (*c*): *Anhydrite in lieu of Sulphuric Acid.*

What is important is that an examination should be made of the process for the manufacture of ammonium sulphate where anhydrite is used in lieu of sulphuric acid in more detail than

has hitherto been extended to this aspect of the subject. Statements have appeared from time to time to the effect that the bye-product ammonia problem may possibly be solved by resorting to the use of anhydrite, in lieu of sulphuric acid, in the manufacture of sulphate of ammonia. Such statements should not be accepted implicitly. Indeed, the whole position should be examined scrupulously. The number of unit processes involved in the utilization of anhydrite in the manufacture of ammonium sulphate is not generally realized. Neither is the importance of large-scale operations, nor the economics of the process, fully appreciated.

Where concentrated gas liquor is used, and sulphuric acid is the source of the SO_3 ion in the manufacture of ammonium sulphate, a gas liquor still with heat interchangers and coolers, and a saturator and equipment, are the only plant involved.

We come now to the cost of anhydrite, having regard to the unit processes involved, in contrast to the price of sulphuric acid. It is known that anhydrite containing (say) 90 p.ct. of calcium sulphate can be obtained in the neighbourhood of the mines at 12s. 6d. per ton, but delivered London or the equivalent, it will cost 25s. per ton. How far the anhydrite process is likely to prove advantageous depends largely on the geographical situation of the ammonia works in relation to the anhydrite mines. The following estimates will doubtless prove interesting, representing as they do, a pecuniary comparison of anhydrite (*a*) under the best conditions, and (*b*) under conditions obtaining in London, as contrasted with the price of sulphuric acid.

EXAMPLE (*a*): *Estimate Based per Ton of Ammonium Sulphate Manufactured, containing 25·5 P.Ct. NH_3.*

	£	s.	d.
(*a*) 24 cwt. of anhydrite at 12s. 6d. per ton at mines, *plus* 2s. 6d. per ton carriage = 15s. per ton	0	18	0
(*b*) Grinding 24 cwt. of anhydrite at 4s. per ton	0	4	10
(*c*) Extra cost for power and labour for filtration and handling the calcium carbonate sludge	0	5	0
(*d*) Interest at 5 p.ct. and depreciation at 7½ p.ct. on extra capital cost of plant—say	0	4	0
(*e*) Extra chemical supervision	0	3	6
(*f*) Cost of treatment of flue gases for carbonatation process	0	2	6
(*g*) Water for cooling and washing precipitated calcium carbonate cake	0	2	6
	£2	0	4

Against the above, where sulphuric acid is used, one has the following charge:

	£	s.	d.
1·11 tons of 70 p.ct. acid at (say) 55s. per ton	3	1	0
Difference in favour of the anhydrite process, per ton of ammonium sulphate manufactured	1	0	8

EXAMPLE (*b*): *Estimate Based per Ton of Ammonium Sulphate Manufactured, containing 25·5 P.Ct. NH_3.*

	£	s.	d.
(*a*) 24 cwt. of anhydrite at 25s. per ton, delivered London, or equivalent	1	10	0
(*b*) This item is identical with example (*a*)	0	4	10
(*c*) ,, ,, ,, ,,	0	5	0
(*d*) ,, ,, ,, ,,	0	4	0
(*e*) ,, ,, ,, ,,	0	3	6
(*f*) ,, ,, ,, ,,	0	2	6
(*g*) ,, ,, ,, ,,	0	2	6
	£2	12	4

Against the above, where sulphuric acid is used, one has the following charge:

	£	s.	d.
1·11 tons of 70 p.ct. acid at (say) 55s. per ton	3	1	0
Difference in favour of the anhydrite process per ton of ammonium sulphate manufactured	0	8	8

The comparison afforded by the two foregoing statements is as accurate as the writer's experience will admit of. The figures show an advantage of 20s. 8d. per ton where anhydrite can be obtained favourably, and 8s. 8d. per ton where the ammonia works is situated in London, or the equivalent.

It is obvious, therefore, that the anhydrite process as an alternative to the use of sulphuric acid needs to be carefully considered. The nature of the process, however, necessitates a medium-sized scale of operations, and it is the writer's view that plant to deal with *less* than 30 to 40 tons of ammonium sulphate per day would not be warranted.

Only one further comment is called for. Where the centrally situated chemical works is sufficiently large, it would, perhaps, be advisable to consider a process which involved the manufacture of di-ammonium phosphate and calcium nitrate from (*a*) concentrated gas liquor, (*b*) ground phosphate rock treated with sulphuric acid in the manufacture of phosphoric acid, and (*c*) the utilization of the precipitated calcium sulphate (which is really in a better form physically than anhydrite) in the production of ammonium sulphate.

Incidentally, the calcium carbonate produced from the latter process could be treated with nitric acid obtained by the oxidation of ammonia (Ostwald process), to yield calcium nitrate and release carbon dioxide for the carbonatation process.

One such cyclic process, possessing distinctive features, has been suggested by Dorr-Liljenroth, and it is certain that more will be heard of the process in the near future.

As far as one can ascertain from a consideration of railway rates and other related data, the radius covered by any centrally-situated chemical works treating concentrated gas liquor or ammonium sulphate solution should not be more than forty miles.

World Power Conference on Fuel.

In our issues for October 3 and 10 will appear further reports and papers before the Conference, together with the discussions. Orders for additional copies of these numbers should be placed early.

CORRESPONDENCE.

[We are not responsible for opinions expressed by Correspondents.]

Valuation of Gas-Works for Assessment.

SIR,—The discussion which took place on the comprehensive paper submitted by Mr. R. M. Simpson, of Denny, to the North British Association of Gas Managers—and in particular the references made to the duty of the Scottish District Executive Board of the National Gas Council in helping to determine new legislation—calls for my deliverance on the activities of the Gas Council and the present position of the intensive subject of valuation of gas-works.

The Management Committee of the Scottish District of the National Gas Council have had the subject intimately before them during the past two years. It was recognized at the outset that amended legislation must have regard to all public utilities—viz., gas, water, electricity, and tramways. It is quite impossible for gas undertakings to press forward proposals on their own behalf, and to do so alone, and without the influence and presence of the other utilities interested. The present-day position of valuation of public utilities, without fair principle and lacking uniformity of practice, is therefore common to all the public services stated, under both company and municipal ownership.

In view of the joint interests involved and arising out of the clamant need for pressing the subject to finality and, if possible, obtaining legislation affecting Scotland—England has, of course, her own Valuation Act of 1926—the Conjoint Conference of Public Utility Associations called for a meeting of representatives in Scotland. The representatives were asked to determine what steps, if any, should be taken to have the existing law and position amended. The meeting took place in the City Chambers, Glasgow, in February, 1927, and was attended by town council, county council, and company representatives of electricity, gas, and water. Mr. W. E. Whyte (as Chairman of the Management Committee) and myself (as Secretary) attended, representing the gas undertakings. A prolonged and tedious discussion took place; the situation being reviewed in light of the fact that the revenue principle had been consecrated by long usage and by a series of decisions of the Court of Session, and of the difficulty of introducing a new principle. It is not prudent, or indeed necessary, that I should detail the views expressed, or the general findings arrived at. It was proposed by Mr. Stenhouse, now Town Clerk of Glasgow, that a Committee should be appointed for the purpose of ascertaining and defining exactly the position as affecting the separate utility undertakings, and to consider what action should be taken subsequently, with a view to promoting legislation. A Committee of seven was appointed, and included are Mr. Whyte and the writer, representing gas. The Committee is still in being, fully armed with complete information, up to date, on the whole subject, and has been at work in influencing Government Departments. More than this, it is not possible to say.

The Convention of Royal Burghs has had the subject under intimate consideration for several years past. This body of Scottish public opinion is conscious of the real and substantial difficulty confronting their own determination to bring about a change in the existing system of valuation of public utility concerns. As regards the Convention, it may be respectfully stated that their representatives are not without diverse interests, having in view the value of the local utility undertaking as a source of income in rates. The Convention of Burghs Committee, it is learned, have now taken a definite step forward; and it is hoped as a result that the matter will enter the region of practical politics in due course. Let me add, as regards the deliberations of the Convention of Burghs Committee, that an agreed-upon arrangement for joint action has been come to with the Committee of Public Utility Representatives.

It is of some interest and value to refer to the opinions expressed by the Judges of the Valuation Appeal Court in the case of the Burgh of Denny in 1927:

> Lord HUNTER: Nothing can be more artificial probably, in the way of valuation, than the determination of the annual value of lands and heritages in the nature of public works, like waterworks, where the owners of the lands and heritages acquire a revenue by rating without any intention of making profit. There have been, in connection with the revenue principle, a considerable number of more or less extraordinary anomalies; and, in reality, if you look at the matter from a scientific point of view, it is often absolutely impossible to justify the results that are reached.
>
> Lord SANDS: The system of valuations, as your Lordship has pointed out, under the revenue principle—if principle it can be called—is extremely obscure and unsatisfactory. It is impossible for us, in applying that principle, to deal out justice; but it is just as impossible for us to deal out injustice.

Arising out of the expressed views of the Judges, a question was asked in Parliament of the Secretary of State for Scotland (Sir John Gilmour), as to whether he had received representations from local authorities, the Convention of Royal Burghs, and other representative bodies in Scotland, directing attention to the anomalies in the valuation of public utility undertakings; and whether, having regard to these facts, the Government would promote legislation to amend the present law and practice. Sir John Gilmour replied that he was aware of the observations on the present method of valuation, and that he had received a number of representations on the subject. The question of introducing legislation to amend the Valuation Act is at present under consideration.

I trust that sufficient evidence has been adduced to prove that weighty representations have been, and will continue to be, made, and that the appointed members acting on behalf of Scottish gas undertakings are in active support. Nothing is to be gained by the impatience that arises from the absence of knowledge or wild gesticulation after immediate results. May I suggest that gas undertakings during this time of negotiation should not individually promote actions in the Court affecting valuation, without reference to the National Gas Council for guidance? Nothing is conceivably worse as likely to confuse the situation and to trammel the best endeavours of the representative bodies now dealing with the matter.

J. W. NAPIER,
Secretary, National Gas Council District Executive Board, Scotland.

Gas-Works, Alloa,
Sept. 22, 1928.

REGISTER OF PATENTS.

APPLICATIONS FOR PATENTS.

[Extracted from the "Official Journal" for Aug. 29.]

Nos. 23,855—24,536.

BEARD, G. F. H.—"Tankless gasholders." No. 24,231.
COLEY, H. E.—"Manufacture of gas." No. 24,414.
FUERY, G. T.—"Gas burners." No. 24,108.
GAS UND TEER GES.—"Generation of water gas." No. 24,294.
GRANT, R. W.—"Electrolytic apparatus for gas manufacture." Nos. 24,366, 24,367.
INTERNATIONAL COMBUSTION ENGINEERING CORPORATION.—"Distillation of tar." No. 23,913.
MILBOURNE, R. J.—See Beard, G. F. H. No. 24,231.
NORGATE, R.—"Apparatus for washing gas." No. 23,955.
PATENAUDE, E. L.—See Fuery, G. T. No. 24,108.
PINTSCH AKT.-GES., J.—"Dry gas meters." No. 24,281.
SOUTH METROPOLITAN GAS COMPANY.—"Fireplaces." No. 24,407.

[Extracted from the "Official Journal" for Sept. 5.]

Nos. 24,537—25,185.

KRISTENSSON, A.—"Removing sulphuretted hydrogen from gases." No. 25,082.
LAING, B.—"Distillation of solid carbonaceous materials." No. 24,717.
NELSON, A. C.—"Apparatus for drying sulphate of ammonia." No. 24,048.
NIELSEN, H.—See Laing, B. No. 24,717.
RICHARDSON, R.—See Nelson, A. C. No. 24,948.
THORP, F.—See Carder, C. H. No. 24,840.
THORSSELL, C.—See Kristensson, A. No. 25,082.
WILTON, T. O.—"Storage of coal gas." No. 24,779.

[Extracted from the "Official Journal" for Sept. 12.]

Nos. 25,186—25,883.

BARRETT COMPANY.—"Recovering coke oven bye-products." No. 25,571.
BARWOLF, R.—"Gas cookers." No. 25,780.
CLIMIE, W.—"Gas producers." No. 25,336.
COLEMAN, F. S.—"Regulating gas supply to atmospheric gas burners." No. 25,342.
COPLANS, S. H.—"Time-controlled gas valves." No. 25,351.
GENERAL GAS APPLIANCES, LTD.—See Coleman, F. S. No. 25,342.
GERRARD, C. W. G.—"Gas producers." No. 25,730.
HELPS, A. M.—"Gas-fired boilers." No. 25,671.
HENEAGE, E.—"Gas producers for motor vehicles." No. 25,398.
HENEAGE, M. B.—See Heneage, E. No. 25,398.
REID POWER DEVELOPMENT COMPANY, LTD.—See Gerrard, C. W. G. No. 25,730.
SOUTH METROPOLITAN GAS COMPANY.—"Pulley-blocks, &c." No. 25,606.
SPENCER, J. A.—"Grids for gas purifiers." No. 25,327.
TURNER, I.—"Gas burners." No. 25,738.
VOITH, H.—"Gas turbines." No. 25,503.
VOITH, J. M.—See Voith, H. No. 25,503.
VOITH, W.—See Voith, H. No. 25,503.

MISCELLANEOUS NEWS.

METROPOLITAN GAS COMPANY OF MELBOURNE.

The Half-Yearly Meeting of the Metropolitan Gas Company was held in Melbourne on Friday, July 27—Sir JOHN GRICE (Chairman of the Directors) presiding.

The CHAIRMAN, moving the adoption of the report and accounts, said that the total quantity of gas sold for the half-year was 2036 million c.ft., compared with 2016 millions for the corresponding half of 1927—an increase of 1 p.ct. The financial depression, which had been experienced over the whole of the half-year, amounted to some extent for the increase in output not being greater. The receipts from residuals, at £135,790 (compared with £159,860 for the June half of last year), show a reduction of £24,000—a decrease of 15 p.ct. The net profits for the half-year amounted to £124,000; and after allowing for payment of the dividend of 7s. 6d. per share, there remained a balance of £1736, which would be added to the amount carried forward.

Owing to a rise in the cost of manufacture, estimated at approximately 9d. per 1000 c.ft., the price of gas was increased by 5d. per 1000 c.ft.—viz., from 6s. 8d. to 7s. 1d.—as from December last. Following a notification to this effect, the Government decided to have an investigation made as to the justification for this increase, and appointed one of the leading officials in the Treasury Department (Mr. T. Forristal) for the purpose. In his report, Mr. Forristal stated that he found that the estimated cost per 1000 c.ft. for the current year, including dividend and reserves, was 7s. 2⅜d.—approximately 7s. 3d.—this figure being based on 1927 manufacturing costs, *plus* increased charges for coal and wages, and assuming a 3 p.ct. increase in total gas consumption, which increase had not eventuated during the six months ended June. He concluded his report by observing that in view of the increased costs of production, the additional revenue obtained from the extra charge of 5d. per 1000 c.ft. in the price of gas would not be sufficient to enable the Company to set aside out of profits a sufficient sum to cover the full provision to reserve as permitted under their Act of Incorporation, unless the Directors were prepared to reduce the dividend rate. Sir John Grice said that, in view of all existing circumstances, it was not thought that the present return on capital subscribed was too high. There had been no watering of stock, and a most important matter to be borne in mind was that the interest on the whole of the money invested in share capital, premium capital, and debenture capital was only 7¾ p.ct.

Mr. LLEWELLYN EVANS seconded the adoption of the report and accounts.

Mr. S. HATTAM moved that a dividend of 7s. 6d. per share be declared out of the profits for the half-year; and Mr. C. B. EVANS seconded the motion, which was carried.

AUSTRALIAN GAS LIGHT COMPANY.

The Annual General Meeting of the Company was held in Sydney on Aug. 9—Mr. GEORGE J. COHEN (Chairman) presiding.

The CHAIRMAN, in moving the adoption of the Directors' report and accounts for the year ended June 30, which recommended the payment of a dividend for the past half-year at the rate of 4 p.ct. on the "A" and "B" shares, referred with regret to the death of one of the Directors, Mr. Alfred George Milson, who was on the Directorate for sixteen years. The vacancy thus created on the Board had been filled by the appointment of Sir John Vicars, K.B. The past year had been a record one. The gross profit made during the year was £449,850, and the net profit, after paying interest on debentures and loans, was £348,362. Dividends for the past year at 8 p.ct. per annum absorbed £303,316, as compared with £282,756 for the previous year. The carry-forward to next year's account was £81,316, which included the sum of £36,270 brought forward from the previous year.

Sydney and suburbs continued to grow, and the demand for gas grew with them, despite the keen competition from electricity and other fuels. The total sales of gas during the past year amounted to 6854 million c.ft., being 379 million c.ft. in excess of the sales for the previous year, or an increase of 5·85 p.ct. During the past seven years, the number of buildings served with gas had increased from approximately 89 p.ct. to 96 p.ct. of the total buildings existing in the area, and it was estimated that the Company to-day served a population of 1,140,000 persons. During the past year 12,138 additional consumers were supplied with gas, the total number on the Company's books at the end of the year being 232,002.

Considerable development had taken place in the use of gas for manufacturing operations in Sydney. At present eighty different trades were using the Company's gas for such purposes; the number of consumers being 914. These consumed 395,874,000 c.ft., being an increase of 25·13 p.ct. over the quantity used for industrial purposes the previous year. Three years ago he drew attention to the then proposed formation of a N.S.W. Commercial Gas Association. This Association was duly formed, and the consequent bringing together of the two allied industries—the suppliers of gas and the manufacturers of appliances—had resulted in the creation of a desire for a central Testing Laboratory. A scheme was gradually evolved, and a few months ago final arrangements for the testing of all kinds of domestic gas appliances were agreed upon. A laboratory had been installed in the Company's premises at Haymarket, and was now engaged on testing work. It was anticipated that early next year a number of appliances offered for sale to the public would bear the "Seal of Efficiency." This seal would be issued only in connection with those appliances which conform to the standards laid down; and should an appliance fail to comply with the standards of the Testing Laboratory, it would not be offered for sale by any gas company member of the Association. In addition to ensuring that gas appliances should conform to specified standards, it would be essential to have control over their installations, so that the service of gas would be satisfactory in all respects. This is now receiving attention, and it was hoped to obtain the necessary power in this regard.

The motion, which was seconded by the DEPUTY-CHAIRMAN (Mr. A. C. Stephen), was put to the meeting and carried unanimously.

CIVIC ADMINISTRATION AT BELFAST.

By a narrow majority, the Belfast Corporation have turned down the recommendation in the special report of Mr. Arthur Collins, the London Accountant, and Expert Adviser of Municipalities, that Mr. J. D. Smith, the Engineer and Manager of the Gas Department, be appointed Labour Adviser, and as from Jan. 1, 1929, take charge of the engagement and transfer of all workmen, whether skilled or unskilled, from time to time required by the various departments, except such technical men as might be specified in a schedule prepared by Mr. Smith in consultation with the heads of the other departments. (See "JOURNAL" for Sept. 12, p. 550.) The recommendation was thrown out not as any reflection of Mr. Smith's capacity to discharge these new duties satisfactorily, but because it was considered he should be left untrammelled to superintend the gas undertaking of which he has made such a brilliant success.

Councillor Major HALL-THOMPSON, in moving the rejection of the clause, said he considered that in the first place it was interfering with the Gas Committee, with Mr. Smith, and with the Ministry of Labour. Above all, it reopened the door to patronage which was closed two years ago when the Council decided to take all unskilled labour through the Labour Exchange.

Councillor M'KINNEY seconded.

Councillor LYLE HALL, supporting, said it would be unfair to ask their Gas Manager to undertake this additional work.

Councillor MIDGLEY suggested that they should appoint someone who could be a sort of *via media* as between the Corporation and the Labour Exchange.

The LORD MAYOR made a special appeal for the retention of the principle in the recommendation; but Major HALL-THOMPSON declined to withdraw his motion.

Alderman Sir CRAWFORD M'CULLAGH supported the Committee's recommendation so far as the principle was concerned, but was opposed to Mr. Smith being relegated. Mr. Smith was a very capable official; he was discharging an important managerial duty; and it would be unfair to ask him to undertake additional work.

The motion for rejection was carried by 21 votes to 17.

SUGGESTION SCHEMES TO PROMOTE CO-OPERATION BY WORKPEOPLE.

In a paper before the Economic Science and Statistics Section of the British Association, Mr. S. Mavor urged the value of "suggestion" schemes as a means of promoting co-operation by workpeople. National Councils, and Committees of representatives of capital and labour, he said, meeting in London may do much to improve industrial relations; how much will depend chiefly on the willingness of both sides to sacrifice to the common cause present advantages, real or supposed. When national negotiating bodies have done their best, there will remain the real and basic task of giving in the workshops practical expression and effect to the awakened spirit of goodwill and co-operation. In the workshops goodwill is lost; in the workshops alone can it be regained. The initiative is with the employer, and it is already being widely exercised. A condition essential to success of effort in this direction is that a firm's relation to its employees shall be inspired by human sympathy and consideration for the interests of the workers, and that all dealings shall be governed by consistent fairness. Where this fundamental condition exists, many methods of promoting co-operation of the workers are practised with success, but he submitted that one of these—suggestion schemes—has received less attention than it deserves.

The purpose of a suggestion scheme is to induce workpeople to apply their intelligence to the work in hand, and to suggest how time, effort, or material may be saved in the doing of it. It is probably true to say that the greatest source of waste in the engineering industry is the comparative stagnation of the reservoir of latent mental abilities and mechanical aptitudes of the men in the workshops. The sluices should be opened, and streams of ideas should be made available for enhancing the workers' earnings and for reducing the cost and improving the quality of the products. "You are not paid for thinking" has been the too frequent snub by the wrong kind of foremen to men who have had the initiative to put their heads out of their shells. Management has not a monopoly of brains. Workmen ought to be paid for thinking; and it is worth while so to pay them. It has been complained on behalf of the workers that under modern workshop conditions they do not have opportunity for self-expression, and that this is a cause of much industrial unrest.

A suggestion scheme provides to the workman wide scope for his legitimate and laudable ambition to exercise his creative abilities, and to stamp his own individuality upon his work; it is a channel through which he can make personal contributions to technical pro-

gress, and so have a conscious share and proper pride in promoting the general advance, while reaping immediate and appropriate reward for his effort. The fuller exercise of his faculties is a source of pleasure to a workman; it increases his self-respect, and enables him the better to realize his place in the industrial and social structure. Suggestion schemes contain large possibilities of fostering goodwill and practical co-operation of the workpeople, and of promoting industrial harmony; they provide opportunities to the workers of increasing the value of their contribution to industry, and of enhancing their earnings by adding the work of their heads to the work of their hands.

GAS REGULATION ACT APPLICATIONS.

AMENDING ORDER UNDER SECTION 1.

Taunton Gas Light and Coke Company.

To provide that section 3 (standard prices) of the Taunton Gas (Charges) Order, 1921, shall be read and have effect as if the standard prices authorized in paragraph (1) thereof were 14d. and 15·2d. per therm respectively, and as if the prices mentioned in paragraph (2) thereof were 13·4d. and 14·6d. per therm respectively.

TRADE NOTES.

Developments in "Cambridge" Pressure Recorders.

Our readers will be interested to learn that the Cambridge Instrument Company, Ltd., have recently developed a new range of pressure recorders for low-pressure measurements. These instruments, which are of the diaphragm pattern, can be used instead of the hydrostatic type of recording gauge for many applications. They are similar in appearance to the well-known "Cambridge" pressure recorders which the firm have supplied in large numbers to practically every industry, for the measurement of higher pressures. The new recorders are made in six standard low-pressure ranges, as follows: 0-4 in., 0-6 in., 0-12 in., 0-24 in., 0-40 in., and 0-60 in. of water, draught or pressure. The charts are 9½ in. in diameter, and the records are exceptionally clear and easily read.

CURRENT SALES OF GAS PRODUCTS.

The London Market for Tar, Tar Products, and Sulphate.

LONDON, *Sept.* 24.

The only change to report in the prices of tar products is a drop in the price of pitch, which is quoted to-day at 45s. to 46s. per ton.

Creosote remains 7⅞d. to 7½d. per gallon.

Pure benzole is about 1s. 8d. per gallon.

Solvent naphtha, 95/160, is 1s. 5d. to 1s. 6d. per gallon.

Pure toluole, 1s. 11d. to 2s. per gallon.

Pyridine bases is about 5s. per gallon.

The market continues very quiet.

Tar Products in the Provinces.

Sept. 24.

Markets for tar products generally are quiet and with an easier tendency in most of the articles.

There is no alteration in the market for pitch. There are sellers at 45s., but not very much inquiry just at present, and Continental consumers are indicating 42s. 6d. as their idea of price, which figure is not acceptable to the producers.

Water-white products are steady, and there is a fair amount of inquiry for all qualities.

Benzole is selling freely.

Solvent naphtha is quoted at 1s. 1½d. to 1s. 2d. *ex* makers' works; heavy naphtha, 1s. to 1s. 0½d.; and toluole, 1s. 5d. to 1s. 6d.

Creosote is quiet. There is not very much business doing, but the exports are good.

Crude carbolic is easier. Business has been done for delivery to the end of the year at 2s., and for the beginning of next year at 1s. 11d. per gallon.

Cresylic acid is quiet, and there is not very much business offering.

Naphthalene is steady, but the demand has fallen away.

The average prices of gas-works products during the week were: Gas-works tar, 32s. 9d. to 37s. 9d. Pitch—East Coast, 43s. 9d. to 46s. 3d. f.o.b. West Coast—Manchester, 38s. 9d. to 39s. 9d.; Liverpool, 40s. 9d. to 41s. 9d.; Clyde, 40s. 9d. to 41s. 9d. Toluole, naked, North, 1s. 5d. to 1s. 6d. nominal. Coal-tar crude naphtha, in bulk, North, 9d. to 10d. Solvent naphtha, naked, North, 1s. 1½d. to 1s. 2d. Heavy naphtha, North, 1s. to 1s. 0½d. Creosote, in bulk, North, liquid, 5½d. to 6½d.; salty, 5⅜d. to 6d.; Scotland, 5⅝d. to 6d. Heavy oils, in bulk, North, 8¼d. to 8½d. Carbolic acid, 60 p.ct., 1s. 11d. to 2s. prompt. Naphthalene, £13 to £15, salts, £5 to £5 10s., bags included. Anthracene, "A" quality, 2½d. per minimum 40 p.ct., purely nominal; "B" quality, unsaleable.

Benzole Prices.

The following are considered to be the market prices to-day:

	s. d.	s. d.	
Crude benzole . . .	0 10½	to 0 11	per gallon at works
Motor ,, . . .	1 4½	,, 1 5	,, ,, ,,
90 p.ct. ,, . . .	1 7	,, 1 8	,, ,, ,,
Pure ,, . . .	1 10	,, 1 11	,, ,, ,,

The price of gas at Clitheroe is being reduced by 3d. per 1000 c.ft. for all purposes; the reduction to commence after the reading of meters on Sept. 30.

COAL TRADE REPORTS.

From Our Own Correspondents.

NORTH-EAST COAST.

There is no improvement to report, and most depressing conditions prevail. There is still a shortage of tonnage, but it is doubtful whether this is affecting the coal market to any great extent, as demand from abroad seems to be at a very low ebb. Gas coals are still waiting for what is called the seasonal demand, and in the meantime are working very irregularly. Northumberlands maintain their slight improvement of the past few weeks, but they are not by any means full of business. The competition of the Five Counties Scheme, and general over-production on the Continent, are making it very difficult to secure export business of any kind.

Wear Special gas makes still quote 15s. 3d. to 15s. 6d. f.o.b., and best qualities 14s. 9d. Seconds and others ask 13s. to 13s. 6d. All are short of orders. Coking coals are in very poor demand. Best makes quote no higher than 13s. 6d., and others are weak down to 13s. or even less. Durham bunkers ask 13s. 9d. for best qualities, and others are 13s. to 13s. 6d. All are freely offered. Northumberland steams still adhere to the fixed minimum prices.

Gas coke is nominally 19s. 6d. to 20s. f.o.b. for shipment, and supplies for prompt delivery are plentiful.

YORKSHIRE AND LANCASHIRE.

Gas coals produced in Yorkshire and Lancashire are in greater request under contract, owing to the shortening of the days and the cooler weather. There is very little forward inquiry for the inland market. Recent sales, however, have not quite fulfilled expectations at the collieries.

Industrial coal moves slowly, with prices in accordance with the position at each supplying pit. The recent advances have, generally speaking, been fairly well received, although in some cases the position has had to be met.

The export market shows a firmness in respect of hards and washed smalls. Other qualities are fairly well sold, but for deliveries a little ahead. Bunker coal has been scarce owing to local holidays, but it is anticipated that the position will ease this week.

The demand for domestic coal has been fairly steady during the past week; but there are indications that further advances in price may be expected to operate as from Oct. 1, possibly on similar lines to those of last month. Restricted outputs and local holidays and feasts have led to accumulated stocks at collieries becoming depleted during the last few weeks. The following are the Humber bunker and export prices, f.o.b. usual shipping ports:

South Yorkshire—Hards, Association, bunkers 20s. to 20s. 3d., export 15s. 6d.; screened gas coal, export 15s. 6d. to 16s.; washed trebles, 15s. 6d. to 16s.; washed doubles, 14s. 6d. to 15s.; washed singles, 13s. 6d. to 14s.; washed smalls, bunkers 15s. to 15s. 3d., export 11s.; rough slack, bunkers 14s. to 14s. 3d.; smithy peas, export 16s. 6d. to 17s. 6d. per ton.

West Yorkshire—Hartley's (f.o.b. Goole), bunkers 17s. 6d., export 14s. to 15s.; screened gas coal, export 14s. to 15s.; washed trebles, 15s. to 15s. 6d.; washed doubles, 13s. 9d. to 14s. 3d.; washed singles, 13s. to 13s. 9d.; washed smalls, bunkers 14s. 6d. to 15s., export 11s.; unwashed trebles, export 14s. 6d. to 15s.; unwashed doubles, 11s. to 11s. 6d.; rough slack, 8s. 9d. to 9s. 3d.; coking smalls, 8s. 6d. to 9s. 6d. per ton.

Derbyshire and Nottinghamshire—Top Hards, bunkers 19s. 6d. to 20s., export 15s. to 16s.; cobbles, export 15s. to 16s.; washed trebles, 15s. 6d. to 16s.; washed doubles, 14s.; washed singles, 13s. 6d.; washed smalls, bunkers 14s. 6d. to 15s., export 11s.; unwashed doubles, export 12s. to 13s.; rough slack, bunkers 13s. 6d. to 14s., export 9s. 6d. to 10s. 6d. per ton.

Yorkshire, Derbyshire, and Nottinghamshire—Screened steam coal, bunkers 17s. 6d. to 18s. 6d., export 12s. to 13s. 3d.; gas coke, export 20s. to 23s.; furnace coke, 19s. to 19s. 6d.; washed steam, Goole, bunkers 16s. to 16s. 6d., Hull, West Yorks., 17s. 9d., Hull, South Yorks., 18s. 3d. to 18s. 6d. per ton.

MIDLANDS.

With the industrial market unresponsive, present hopes centre in the development of the seasonal demand for lighting and heating. During the first three weeks of September householders were mostly indifferent about augmenting their coal supplies. There was a steady absorption of the high-grade coals, on which advances of several shillings were obtainable in many cases. Taken all round, however, the advance did not exceed 1s. or 1s. 6d., and many collieries had to accept the best prices they could get in a very dull market.

With the weather becoming colder, and the period of "summer time" approaching its close, there has been a brisk demand, but not enough materially to strengthen prices. As long as supplies are abundant the generality of householders will consult their own convenience as to buying.

It is noted in the trade that with the controlled pits on a 65 p.ct. quota there is very little surplus coal above ground. With no transport difficulties to obstruct them, collieries have cleared their output pretty regularly. There is comparatively little coal standing on rail. Merchants, warned by their experience last year, have not stocked so heavily as usual. Any expansion of the market will therefore quickly be felt at the collieries. With so much unemployment, the public refuse to believe in the possibility of a squeeze, however.

Bakers nuts continue in good demand for the London market. For ordinary "D.S." nuts prices range from 8s. to 11s. 6d. Slacks are not being taken up quite as fast as they are produced, and good nutty samples are offered at 6s. upwards.

CONTRACTS OPEN.

Coal.

The Gas Committee of the Lytham Saint Annes Corporation invite tenders for the supply of coal. [See advert. on p. 687.]

Gasholder and Tank.

The Gas Committee of the Borough of Chorley invite tenders for the supply and erection of a three-lift spirally guided gasholder and steel tank. [See advert. on p. 687.]

South Australian Gas Company.—The annual report of the Directors for the year ended June 30 states that the profit amounted to £92,521. This has been applied in the payment of a dividend for half-year ended Dec. 31, 1927, at the rate of 8 p.ct. per annum, and a dividend for half-year ended June 30 last, at the rate of 8 p.ct. per annum; and the transference of £4389 to the special purposes fund.

Tamworth Gaslight and Coke Company.—At the recent annual meeting of the Company, Dr. A. E. Richardson, the Chairman, reported a profit of £3594 for the year ended June 30 last. A dividend for the first half-year at the rate of 10 p.ct. per annum on the old shares, and 7 p.ct. on the new shares, less tax, was paid in March last, and similar dividends for the second half-year were unanimously approved. It was reported that additional capital of £3000 was fully subscribed at a premium.

Increased Gas Sales at Singapore.—The report of the Gas Engineer to the Municipality of Singapore (Mr. F. Bedford) for the year ended Dec. 31, 1927, shows that the amount of gas manufactured was 316 million c.ft.—an increase of 8·8 p.ct. on the figure for the previous year. The quantity of gas used for public lighting represented 35·7 p.ct. of the total output. The amount of gas sold to private consumers was 167 million c.ft.—an increase of 11 p.ct. The steady demand for cookers and water heaters has been maintained; the total number of cookers on hire at Dec. 31, 1927, being 1175, against 720 at the end of 1926. The net profit on the undertaking was $129,369, compared with $112,146 in 1926.

Gas Leakage at Audley.—At a meeting of the Audley Urban District Council, Mr. E. Latham (Chairman of the Gas Committee) stated that for many years there had been an abnormal leakage of gas between the recorded quantity made and the quantity sold. It was recently thought that the public lamps were responsible for some of this leakage; and tests were being undertaken to discover if this was so. The total quantity of gas made during the year ended March 31 last was 19 million c.ft. The total registered sales amounted to 11,787,400 c.ft., and the works consumption was estimated at 150,420 c.ft., thus leaving 5,554,000 c.ft. unaccounted for, or a leakage of 29·06 p.ct. of the gas manufactured.

Safety in Mines Research Board.

Although knowledge regarding mine explosions has been greatly advanced, the cause of several such occurrences remains a mystery, and it becomes necessary to explore all possible sources of initiation. Among these is the question whether the self-electrification of a dust cloud can give rise to dangerous electric sparking such as might ignite firedamp or coal dust; and the first stage of an investigation of this problem forms the subject of a paper entitled "Spontaneous Electrification in Dust Clouds, with special reference to Coal Dust Clouds," by S. C. Blacktin (S.M.R.B. Paper No. 43, H.M. Stationery Office, price 6d. net). The research so far has shown conclusively that electricity is generated in coal dust clouds raised in a current of air; that the quantity of electricity generated increases with the speed of the air current and with the weight of dust used, and varies with the sample of coal; and that sparks may be obtained from the charges so generated. Whether the igniting power of these sparks is sufficient to initiate a gaseous or coal dust explosion is now being examined.

Good Working at Deal.—The report of the Directors of the Deal and Walmer Gas Company for the year ended June 30 states that the gas sold shows an increase of 3·7 p.ct. After paying the dividend on the 6½ p.ct. preference stock, the Directors recommend a final dividend on the ordinary stock of £7 5s. p.ct. per annum, which, with the interim dividend of 7 p.ct. per annum paid in March last, makes a total distribution of £7 2s. 6d. for the year.

Low-Temperature Carbonization and the Coal Industry.—Moving the adoption of the report and accounts of the Directors of the Old Silkstone Collieries, Ltd., for the year ended March 31, Major Frank Middleton, the Deputy-Chairman, said that considerable progress in low-temperature distillation of coal had been made during the past year; certain plants being now in successful practical and commercial operation. They were watching the position closely; and had trade conditions been more favourable, they would no doubt have been more actively interested. They did not consider, as many people did, that it was a primary essential of all low-temperature distillation processes to produce a solid smokeless fuel. For every ton of smokeless fuel produced in this way, a similar weight of best house coal was discarded from the market. The line of investigation which they had followed so far with the most encouraging results was the distillation of low-grade slacks for the recovery of oil and the production of a solid fuel in the form of a semi-coke which had been proved to be pre-eminently suitable, much more so than raw coal, as a pulverized fuel. They believed that along this channel there rested great prospects of bringing a substantial accretion of revenue to the coal industry, and at the same time a material reduction in the cost of the power factor to industries generally.

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White City Section of the British Industries Fair.—Space in the London section of the British Industries Fair, to be held at the White City from Feb. 18 to March 1, is being booked up more quickly than ever before; the total stand area reserved up to now exceeding 230,000 sq. ft., as compared with 191,000 sq. ft. at the same time last year.

Health Exhibition and Congress.—The Council of the Royal Sanitary Institute have accepted the invitation of the Sheffield City Council to hold their 40th Congress and Health Exhibition at Sheffield from July 13 to 20, 1929. A public meeting to inaugurate the arrangements will be held in the Town Hall, Sheffield, on Friday, Oct. 19, at 3 p.m., under the chairmanship of the Lord Mayor of Sheffield.

Coatbridge Gas Company.—The ordinary general meeting of the Company was held on Sept. 13—Mr. A. S. Legat, the Chairman, presiding. The Directors' report for the year ended June 30 last showed that the sales of gas for the twelve months amounted to 1,256,344 therms, being a decrease of 58,926 therms, or 4·48 p.ct., compared with the previous year. Dividends were recommended as follows: £14 5s. on the original stock, and £9 19s. 6d. p.ct. on the four issues of £10 shares, all less income-tax. The report was adopted, and dividends were declared as recommended.

Cheaper Gas at Sedgley.—At a meeting of the Sedgley District Council recently, a balance-sheet in connection with the gas undertaking was presented. The main difficulties through lack of working balance had now, it was stated, been overtaken, and there was an unappropriated balance of £4200. The Gas Committee accordingly proposed that, as from the end of the September quarter, the price of gas be reduced by 9d. per 1000 c.ft. The gas produced was lower by more than two million c.ft., and the sales had diminished, but the unaccounted-for gas had been reduced. The net profit for the year was £3775. The amount spent on renewals was £3923, and the capital expenditure £1465. The price of gas had been 4s. 6d. per 1000 c.ft.

Tar Fumes and Cancer.—At an inquest on W. C. Yates, the Coroner, Mr. W. R. Dauncey, returned a verdict that the man had died from wastage due to cancer of the scrotum caused by exposure to tar fumes while following his occupation at the Tredegar Gas-Works. Mr. D. Walter Davies, Engineer and Manager to the Tredegar Gas and Water Department, stated that deceased had been employed at the Council's gas-works for forty years, during 36 of which he acted as a stoker. Mr. Davies said that four years ago a bath fed with hot water was installed at the works, so that Yates' disease must have originated more than four years ago. Notices were posted in the works drawing the attention of the men to the great need for cleanliness. Dr. T. R. Sutherland, in his evidence, stated that cleanliness was the only preventative against disease in men who worked in tar fumes.

Seventh National Cost Conference.—The Seventh National Cost Conference of the Institute of Cost and Works Accountants will be held at the Queen's Hotel, Birmingham, on Friday, Sept. 28. At the morning session, commencing at 10.30 a.m., Mr. Alexander Ramsay (Chairman of the Birmingham and District Engineering and Allied Trades Employers' Association) will preside, and the subject of "Cost Accounting and the Industrial Future" will be introduced by Mr. J. A. Lacey (Birmingham) and Mr. J. Wardropper, B.Sc., B.Com. (York). The subject of "The Standardization of Cost Accounts" will be introduced by Mr. B. Thistlethwaite (Manchester) at the afternoon session at 2.30 p.m., when Sir Holberry Mensforth, K.C.B., C.B.E., will preside. The annual dinner of the Institute will take place at 7.15 p.m. on the same day at the Queen's Hotel, Birmingham, when the chief guest will be the Rt. Hon. Lord Askwith, K.C.B., K.C.

Profit at Oswaldtwistle.—A net profit of £3093 on the Oswaldtwistle gas undertaking was reported to the Council on Sept. 20. The income was £27,996, the expenditure £22,262, and the gross profit £5734. The outstanding debt was £28,353, increased by £10,000 during the year, owing to the provision of a new gasholder. The Engineer, Mr. A. F. Ames, was preparing a special report regarding a suggested reduction in price. Mr. Read said that the Department made over £3000 last year, and had over £5000 in reserve. This was ample for contingencies. If they lowered the price ½d. a therm, it would mean £1200 less income; but even then the undertaking would show a profit. The Chairman said he favoured a price reduction, but the question of withdrawing profits from the undertaking for rate relief would have to be reconsidered in the face of keen competition from electricity. He pointed out that street lighting, which had to be carried out by the Gas Department, was equal to 3d. per 1000 c.ft. of gas sold, and the relief to the rates by this means was 5½d. in the pound. But for this, the price could have been reduced to pre-strike figures.

Seventieth Birthday of Gas Mantle Inventor.—Austria has just celebrated the seventieth birthday of Karl Freiherr Auer von Welsbach, the inventor of the incandescent gas mantle. The son of a former head of the Austrian State printing works, and himself an inventor in printing and paper-making processes as well as compiler of an interesting work, "The Hall of Tongues, or The Lord's Prayer in 608 Languages" (Vienna, 1844), Karl von Auer studied at the University of Heidelberg under the famous Baron de Bunsen, concentrating in his researches upon the chemistry of the rare earths, with results which were later to be of the greatest importance to both scientific and technical developments. His invention of the incandescent mantle, after many long and unsuccessful experiments, revolutionized the gas industry, and brought great wealth to von Auer. But his genius did not end there. Twelve years later, in 1897, he brought out the osmium filament lamp, and in 1903 the ferrocerium compound (or Auer metal) used in making the modern pocket-lighters. To-day he is as active and scientifically alert as ever. In his castle in Carinthia he has the most up-to-date chemical and physical research laboratories, in which his researches are still being pursued.

Gas Charges Reduced at Falkirk.—In moving the adoption of the Finance Committee's recommendations at a recent meeting of the Falkirk Town Council, Mr. Bell, the Treasurer, said that last year the Gas Department started with a debit balance of £8266, as a result of the 1926 coal strike. The results for 1927-28, however, had reduced this debit to £462. The make of gas was 337 million c.ft., being 3 million c.ft. more than in the previous year. It was proposed that the price of gas to all classes of consumer be reduced by 0·9d. per therm, equivalent to almost 4d. per 1000 c.ft., as from the beginning of the second quarter for prepayment consumers, and for all other purposes as from the October survey. The new charges would be as follows: To ordinary consumers, 3s. 1·84d. per 1000 c.ft.; to prepayment consumers, 3s. 3·99d.; and to industrial consumers, 2s. 6·96d., subject to the usual discounts. "We can look forward with confidence to further reductions from this splendidly equipped and managed Department," said Mr. Bell. "Those responsible for its conduct are well worthy of praise for the results achieved." The Engineer and Manager of the Gas Department is Mr. H. G. Ritchie.

Continental Union Gas Company, Ltd.—The report of the Directors for the year ended June 30 last, which will be presented at the meeting of the Company to be held at Winchester House, Old Broad Street, on Tuesday, Oct. 9, states that the French undertaking, with which the Company is closely connected, continues to make satisfactory progress. It may be said now to be no longer hampered by the complications consequent upon war-time dislocation and post-war readjustments. After deducting management expenses and pensions charges, and transferring £6000 to Exchange reserve account (against £3000 last year), the balance at the credit of profit and loss account at the close of the year, including £1288 brought forward, was £19,085. Out of this balance there has been paid an interim dividend on the preference stock of 3½ p.ct., less income-tax, for the half-year to Dec. 31, 1927, £5600. The Directors recommend the payment of a final dividend on the same stock at the same rate, less income-tax, for the half-year to June 30 last, making 7 p.ct. for the year, £5600. They also recommend a distribution of 1 p.ct., less income-tax, on the ordinary stock for the year to June 30, absorbing £6400, leaving a balance to be carried forward of £1485.

The Ministry of Health has sanctioned the borrowing of £3419 by the Congleton Town Council for improvements at the gas-works.

The Plymouth Corporation Gas Department secured the second prize in the trade advertisement class in the commercial vehicles parade in connection with a Devonport carnival.

A contract for the street lighting at Kenilworth has been arranged between the local Urban Council and the Coventry City Council. The price will be 15 p.ct. less than that charged to domestic consumers.

Mr. C. S. Shapley, the Leeds City Gas Engineer and General Manager, is the Executive Officer (voluntary) for the Municipal Display Group in connection with the organization of the Leeds Civic Week, Sept. 22 to 29. All municipal undertakings—including the Gas Department—have been thrown open to public inspection.

A Special Sub-Committee of the Bradford Corporation have instructed the Town Clerk to secure from other municipalities information with regard to the appointment of public lighting superintendents, with a view to consideration of the desirability or otherwise of the creation of a separate public lighting department in Bradford.

The Blackpool trading departments during the past municipal year made a net profit of £113,232 on an income of £836,177. The figures for the Gas Department were as follows: Income, £207,846; expenditure, £158,845; gross profit, £49,001; and net profit, £33,116. Credits in aid of rates totalled £21,000, including £10,000 from the Gas Department.

A man named William Swain, of Hastings, was overcome by an escape of gas while working at the junction of a main at Wellington Mews, Hastings, recently. He collapsed into a state of semi-consciousness, and first aid was rendered by ambulance men. He was then taken to the Royal East Sussex Hospital, where oxygen was administered. After detention for a few hours he was able to go home.

The Worcester New Gas Light Company announced that from the reading of the meters for the September quarter, the charge for gas will be 3s. 9d. per 1000 c.ft., subject to a discount of 10d. per 1000 c.ft., and a further discount of 2d. per 1000 c.ft. for motive power when the gas consumed is registered by a separate meter, on payment of account within one month from the end of the month next following each quarter day.

The Lord Mayor of Bradford (Alderman M. Conway) opened the cookery demonstrations last week which are being organized at the Mechanics' Institute by the Bradford Corporation Gas Department until Sept. 29. The Lord Mayor said that the clearer atmosphere of the city was due to the more general use of gas cookers. On behalf of the Gas Department, Mr. S. H. Packer, of the Darley Street Showrooms, thanked the Lord Mayor for his presence. The demonstrations are being carried out by Miss Tuxford.

Last Saturday night there was a breakdown at the Dewsbury Corporation Electricity Works. At 8.50 p.m. the generator broke down, and this involved complications on the main switchboard, and cut off the service in the old borough, which includes the shopping centre. It was not possible to restore the light until 10.50 p.m. As the streets and shops in the centre of the town are almost entirely illuminated by electricity, and as Saturday night is a busy market night, the tradesmen and shoppers found themselves in an awkward predicament. The crowds were extremely orderly, and though special precautions were taken by the police, these were not needed. At the suggestion of the police, however, the jewellers closed their premises.

STOCK MARKET REPORT.

THERE was a moderate show of activity on the Stock Exchange last week, with Industrials absorbing the greatest amount of interest.

The Gas Market was quite active. Transactions were numerous, and a number of quotations moved upwards, debenture stocks especially being in demand. Of these stocks, Cape Town 4½ p.ct. rose 3 points to 73-78, and Maidstone 3 p.ct. 2 points to 55-58. It will be seen by the Table that Continental Union ordinary dropped 2 points. This is probably due to the statement in the report issued last week that some re-arrangement of the capital account will be necessary. The Imperial Continental Company have announced an interim dividend for the past half-year at the rate of 10 p.ct. per annum, which is the same as for the corresponding period of 1927. Among the lesser companies it is noted that the additional "B" capital stock of the Horley District Gas Company changed hands at 150. A higher dividend, £7 12s. 6d. p.ct. per annum, is being paid by the Alliance and Dublin Company for the past half-year.

Issue.	Share.	When ex-Dividend.	Dividends. Prev. Hf.Yr	Dividends. Last Hf. Yr.	NAME.	Quotations. Sept. 21.	Rise or Fall on Week.	Transactions Lowest and Highest Prices.
£			%p.a	% p.a.				
171,978	Stk.	Aug 30	5	5	Aldershot 5 p.c. max. C. .	72—77	..	..
412,992	,,	Apl." 13	4	4	Do. 4 p.c. Pref. . .	68—71	..	..
1,561,868	,,	July 12	7	7	Alliance & Dublin Ord. .	98—101	+1	..
374,000	,,	Aug. 30	4	4	Do. 4 p.c. Deb. . .	68—66	..	..
593,654	,,	Aug. 30	7	7	Barnet Ord. 7 p.c. . . .	109—112	..	..
300,000	1	Apl. 26	1/7½	1/7½	Bombay, Ltd.	21/—23/-	..	21/3
170,000	10	Aug. 30	8½	8½	Bournemouth 5 p.c. . . .	12½—13½	..	..
500,050	10	,,	7	7	Do. B 7 p.c. . .	12½—12⅝	+¼	12⅝—12⅝
875,000	10	,,	6	6	Do. Pref. 6 p.c. .	10½—11¼	..	11—£11/6/9
50,000	Stk.	July 12	3	3	Do. 3 p.c. Deb. . .	56—59	..	57
162,025	,,	,,	4	4	Do. 4 p.c. Deb. . .	75—78	..	..
357,900	,,	Aug. 30	7½	7½	Brighton & Hove 6 p.c. Con.	114—117	..	..
341,880	,,	,,	6½	6½	Do. 5 p.c. Con.	101—104	..	..
1,387,500	,,	July 26	5	5	Bristol 5 p.c. max. . . .	90½—91½a	..	..
865,000	,,	Mar. 22	8	7	British Ord.	114—117	..	115½
100,000	,,	June 28	7	7	Do. 7 p.c. Pref. . . .	114—117	..	..
190,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. .	74—77	+1	..
200,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. .	95—98	+1	..
100,000	10	May 24	6	8	Cape Town, Ltd. . . .	8—9	..	..
100,000	10	Apl. 26	4½	4½	Do. 4½ p.c. Pref. . .	6¾—7¼	..	..
150,000	Stk.	June 28	4½	4½	Do. 4½ p.c. Deb. . .	78—78	+3	..
426,860	,,	July 26	6	6	Cardiff Con. Ord. . . .	96—99	..	..
387,840	,,	June 28	7½	7½	Do. 7½ p.c. Red. Deb. .	100—103	..	..
157,150	,,	Aug. 16	6½	5	Chester 5 p.c. Ord. . . .	88—93b	..	..
79,185	1	Apl. 26	†2/-	†2/-	Colombo Ltd. Ord. . . .	33/—38/-	..	..
24,495	1	,,	1/4½	1/4½	Do. 7 p.c. Pref. .	21/—28/-	..	..
375,402	1	Apl." 12	1/9½	1/9½	Colonial Gas Assn. Ld. Ord.	23/—25/-	..	..
187,848	1	,,	1/7½	1/7½	Do. 8 p.c. Pref.	21/—23/-	..	..
2,078,280	Stk.	July 26	7	8	Commercial Ord. . . .	97—100	..	98½—99½
475,000	,,	June 14	8	8	Do 8 p.c. Deb. . .	57—60	..	58½
800,000	,,	Sept. 29	11	11	Continental Union, Ltd. .	30—35	−2	30—32
100,000	,,	Mar. 8	7	7	Do. 7 p.c. Pref. . .	92—97	..	..
787,560	,,	Aug. 16	7	7	Croydon sliding scale . .	108—111	+1	109⅝
109,100	,,	,,	5	5	Do. max. div. . . .	83—86	..	85½—86
493,270	,,	Aug. 16	10	7	Derby Con.	115—120c	..	..
55,000	,,	June 28	4	4	Do. Deb.	71—78c	..	..
209,000	,,	Aug. 30	5	5	East Hull Ord. 5 p.c. . .	75—78	..	..
50,000	,,	June 28	5	5	Eastbourne 5 p.c. Deb. .	94—97	..	..
1,002,180	10	Sept. 13	16	14	European, Ltd.	8—9*	..	8⅝—8¹¹⁄₁₆
19,703,480	Stk.	July 26	5/1/1	5½	Gas Light & Coke 4 p.c. Ord.	19/4½—19/10½f	..	19/4½—19/9
2,800,000	,,	,,	3½	3½	Do. 3½ p.c. max. . .	62—64	..	63—63½
4 187,020	,,	,,	4	4	Do. 4 p.c. Con. Pref. .	77—80	..	78½—79⅝
5,802,630	,,	June 14	3	3	Do. 3 p.c. Con. Deb. .	61—63	+1	61—61½
181,315	,,	,,	6	6	Do. 6 p.c. Br'tf'd Rd. Db.	108—106	..	..
1,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. .	99—101	..	..
42,000	,,	—	7½	7½	Do. 7½ p.c. Ilford Deb. .	..	..	..
92,500	,,	Aug. 30	6⅔	7	Hastings & St L. 5 p.c. Conv	88—93	..	..
258,740	,,	,,	5⅓	5⅓	Do. 3½ p.c. Conv.	71—75	..	..
70,000	10	Apl. 26	10	‡10	Hongkong & China, Ltd. .	13¾—14½	..	14—14½
172,200	Stk.	Aug. 30	5	5½	Hornsey Con. 3½ p.c. .	85—87	..	..
1,976,000	,,	May 24	10	10	Imperial Continental Cap.	171—176	..	173—178½
338,130	,,	Aug 16	3½	3½	Do. 3½ p.c. Red. Deb.	67—69	..	69
385,342	,,	Aug. 16	7	7½	Lea Bridge 6 p.c. Ord. . .	98—101	..	..
2,145,907	,,	Aug. 16	5½	5½	Liverpool 5 p.c. Ord. . .	90—91b	..	..
600,000	,,	Mar 22	7	7	Do. 7 p.c. Red. Pref.	103½—105½b	..	..
165,736	,,	Aug. 16	8	9	Maidstone 8 p.c. Cap. . .	112—117	..	..
63,480	,,	June 14	3	3	Do. 3 p.c. Deb. . .	55—58	+2	..
75,000	5	June 14	†8	†8	Malta & Mediterranean .	5½—6½	..	..
541,920	Stk.	May 24	†5	†7	Montevideo, Ltd. . . .	96—97	+½	95½—96½
2,061,315	,,	Aug. 16	5	5	Newcastle & Gateshead Con.	16/—16/9d/	..	..
360,929	,,	,,	4	4	Do. 4 p.c. Pref. .	73—74d	..	..
691,705	,,	June 28	8½	8½	Do. 8½ p.c. Deb. .	69½—70½	..	..
131,780	,,	Aug. 30	6/18/0	7/1/0	North Middlesex 6 p.c. Con.	96—99	..	..
900,000	,,	Apl. 26	9	7	Oriental, Ltd.	116—118	..	..
188,190	,,	June 28	7½	7½	Plym'th & Ston'house 5 p.c.	107—112	..	..
414,500	,,	Aug. 30	7½	7½	Portsm'th Con. Stk. 4 p.c. Std.	99—102	..	..
336,782	,,	,,	5	5	Do. 5 p.c. max.	76—79	..	..
1,334,464	1	—	—	—	Primitiva Ord.	23/9—24/9	..	24/—24/6
244,500	100	June 1	4	4	Do. 4 p.c. Red. Deb. .	91—94	..	92½—93
695,000	Stk.	July 26	4	4	Do. 4 p.c. Red. Deb. 1911	78—80	..	..
416,845	,,	June 28	4	4	Do. 4 p.c. Cons. Deb. . .	78—80	..	..
150,000	10	Mar. 22	6	6	San Paulo 6 p.c. Pref. . .	82—87	..	..
370,000	Stk.	Aug. 30	6	6⅓	Sheffield A	103½—104½e*	..	..
419,988	,,	,,	6	6⅓	Do. B	103½—104½e*	..	..
1,047,000	,,	,,	6	6⅓	Do. C	103½—104½e*	..	..
90,000	10	June 14	‡3	‡4	South African	4—6	..	..
6,609,895	Stk.	July 26	7½	8	South Met. Ord.	106—108	..	106½—107½
500,000	,,	,,	6	6	Do. 6 p.c. Irred. Pf.	110—113	..	112—112½
1,895,448	,,	July 12	8	8	Do. 8 p.c. Deb. . .	59—61	..	59½—60½
784,000	,,	Sept 13	6½	6½	Do. 6½ p.c. Red. Db.	99—101*	..	..
91,500	,,	Aug. 16	8½	8½	South Shields Con. . . .	108—110d	..	..
1,348,795	,,	July 26	6½	6½	South Suburban Ord. 6 p.c.	105—108	..	106½—107½
868,887	,,	June 28	5	5	Do. 5 p.c. Deb.	97—100	..	99½
647,740	,,	Aug. 30	5	5	South'mpton Ord. 5 p.c. max.	77—79	..	..
121,278	,,	June 28	4	4	Do. 4 p.c. Deb.	72—75	..	..
250,000	,,	Aug 30	7	7	Swansea 7 p.c. Red. Pref. .	98—101	..	..
300,000	,,	June 28	6½	6½	Do. 6½ p.c. Red. Deb.	99—102	..	..
120,000	,,	July 26	7½	8	Tottenham District A 5 p.c.	117—122	+1	119—120½
989,275	,,	,,	6½	6½	Do. B 3½ p.c.	99—102	+1	100—101½
159,000	,,	,,	5½	5½	Do. 5½ p.c. Pref.	96—98	..	..
121,355	,,	June 14	4	4	Do. 4 p.c. Deb.	76—79	..	77½—78½
289,094	,,	Aug. 30	6⅔	6⅔	Uxbridge, Maidenhead, & Wycombe 5 p.c. . . .	89—94	..	..
98,880	,,	,,	6	6	Do. 5 p.c. pref. .	86—91	..	87½
80,000	,,	July 12	8½	8½	Wandsworth, Wimbledon, and Epsom— Wandsworth A 5 p.c. .	126—129	..	127—128
355,636	,,	,,	7	7½	Do. B 3½ p.c. .	108—113	..	110½—111½
482,535	,,	,,	5/19/0	6½	Do. C and New	96—101	..	..
852,000	,,	,,	6⅔	6⅔	Do. Wimbledon 5 p.c. .	104—109	..	..
92,000	,,	,,	7½	7½	Do. Epsom 5 p.c. . .	110—115	..	113½—113½
300,000	,,	,,	5	5	Do. 5 p.c. Pref . . .	88—91	..	..
85,416	,,	June 28	3	3	Do. 3 p.c. Deb. . . .	56—59	..	57½
244,743	,,	,,	4	4	Do. 4 p.c. Deb. . . .	75—78	..	..

Quotations at:—a.—Bristol. b.—Liverpool. c.—Nottingham. d.—Newcastle. e.—Sheffield. f.—The quotation is per £1 of Stock. * Ex. div. † Paid free of income-tax. ‡ For year.

The following transactions were recorded during the week:

On Monday Bournemouth "B" 12⅝, 3 p.ct. debenture 57, Croydon maximum dividend 85½, Gas Light and Coke 19s. 6d., 19s. 8¼d., 19s. 9d., 3½ p.ct. maximum 63½, 63½, 63⅝, 63⅞, 3 p.ct. debenture 61, Montevideo 95⅝, 95⅞, 96, Newcastle and Gateshead 3½ p.ct. debenture 69¾, Primitiva 24s. 3d., 24s. 4½d., 24s. 6d., South Metropolitan 106⅜, 6 p.ct. preference 112½, Tottenham "A" 119, "B" 100, 101, 4 p.ct. debenture 77½, Uxbridge, Maidenhead, 5 p.ct preference 87½, Wandsworth 3 p.ct. debenture 57½. Supplementary prices, Brighton and Hove 6 p.ct. "B" preference 109½, Gas Light and Coke 5 p.ct. debenture 1952-57 101¼, Liverpool 5 p.ct. 90½, Metropolitan (of Melbourne) 5½ p.ct. debentures (issued at £100, £50 paid) 49⅜, 50, South Shields new 109, Tottenham 5 p.ct. Reg:, 98½.

On Tuesday, Croydon maximum dividend 86, European 8⁹⁄₁₆, 8⅝, Gas Light and Coke 19s. 6d., 19s. 9d., 4 p.ct. preference 78½, Montevideo 96½, Primitiva 24s., 24s. 1½d., 24s. 4¼d., South Metropolitan 107½, Tottenham 4 p.ct. debenture 78½. Supplementary prices, Gas Light and Coke 5 p.ct. debenture 1952-57 101½, Hampton Court 5 p.ct. consolidated 103, 104, Metropolitan (of Melbourne) 5½ p.ct. debentures (issued at £100, £50 paid) 50.

On Wednesday, Bombay 21s. 3d., Bournemouth 6 p.ct. preference 11, Continental Union 32, Gas Light and Coke 19s. 6d., 19s. 7½d., 3 p.ct. debenture 61½, Montevideo 95½, 96, Primitiva 24s., 24s. 1½d., 24s. 3d., 24s. 4½d., South Suburban 107, 107⅜, Tottenham "B" 100½. Supplementary prices, Cheltenham 5 p.ct. maximum 75, Gas Light and Coke 5 p.ct. debenture 1952-57 101¼, Liverpool 5 p.ct. 90.

On Thursday, Bournemouth "B" 12⅜, Continental Union 30, European 8¹¹⁄₁₆, Gas Light and Coke 19s. 5½d., 19s. 6d., 19s. 7½d., 19s. 8½d., 4 p.ct. preference 78⅝, Hong Kong and China 14, 14½, Imperial Continental 173, 173½, 173⅛, 3½ p.ct. debenture 68, Primitiva 24s., 24s. 3d., 24s. 6d., 4 p.ct. 1st debentures 92½, 93, South Metropolitan 106½, 107, 107⅛, 107⅜, 6 p.ct. preference 112, 3 p.ct. debenture 59½, 60, 60½, South Suburban 106½, 5 p.ct. debenture 99⅜, Tottenham "A" 120½, "B" 100½, 101½. Supplementary prices, Brighton and Hove 5½ p.ct. debenture 97, Gas Light and Coke 5 p.ct. debenture 1952-57 101¼, 101⁹⁄₁₆, Liverpool 5 p.ct. 90, 90½, 91.

On Friday, Bombay 21s. 3d., Bournemouth "B" 12½, 12⅝, 6 p.ct. preference £11 6s. 9d., British 115½, Commercial 98¾, 99½, 3 p.ct. debenture 58½, Croydon sliding-scale 109⅝, Gas Light and Coke 19s. 4½d., 19s. 6d., 19s. 7½d., 19s. 8½d., 19s. 9d., 3½ p.ct. maximum 63, 63½, 63⅝, 4 p.ct. preference 78½, 78⅝, Imperial Continental 173½, Liverpool 7 p.ct. preference 103⅜, 104½, Primitiva 24s., 24s. 1½d., 24s. 3d., 24s. 4½d., 24s. 6d., South Metropolitan 106½, 107½, 107⅝, Wandsworth "A" 127, 128, "B" 110½, 111½, Epsom 5 p.ct. 112½, 113½, Wandsworth 3 p.ct. debenture 57½. Supplementary prices, Brighton and Hove 5½ p.ct. debenture 99⅜, Gas Light and Coke 5 p.ct. debenture 101½, Liverpool 5 p.ct. 90½, Wandsworth 5 p.ct. debenture 99½, 99⅝.

In Lombard Street, money was fairly plentiful. During the earlier hours on Friday 3½ p.ct. was quoted for new money; but the rate soon fell, and at the close 3 p.ct. only was asked. There was a keen demand for Treasury Bills; and in consequence the average rate, as compared with the previous week, fell over 3s. 2½d. p.ct. to £4 1s. 3·85d. p.ct. This led to a general depreciation of discount rates.

On the Foreign Exchange Market, the New York rate was easier in tendency, and, after falling to below 4.85, finished at 4.85⅛. The Berlin rate declined to 20.34½; Italian lire to 92.72½; and pesetas to 29.36. French francs were unaltered at 124⅜; Dutch florins were easier at 12.09⁹⁄₁₆; and Belgas were quoted at 34.90½.

Silver was a firm market, with both India and China supporting at 26⅝d. per oz. No Gold was available, and the price remained nominally at 84s. 11½d. per oz.

The Bank Rate is 4½ p.ct., to which it was reduced from 5 p.ct. on April 21, 1927. The Banks' deposit rate is 2⅞ p.ct., and the deposit rates of the discount houses are 2½ p.ct. at call and 2¾ p.ct. at notice.

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THE UNIVERSITY OF LEEDS.

APPLICATIONS are invited for Ap- pointment as RESEARCH CHEMIST in the Department of Coal Gas and Fuel Industries, primarily for Researches on Carbonization under the Joint Committee of the Institution of Gas Engineers and the University of Leeds.

Commencing Salary £600–£700 per Annum, according to Qualifications and Experience.

Applications will be received up to Oct. 31 by the REGISTRAR, THE UNIVERSITY, LEEDS, from whom further Particulars may be obtained.

BUCKHAVEN AND LEVEN GAS COMMISSIONERS.

JUNIOR Technical Assistant required by the above Undertaking. Must be good Draughtsman, have fair Chemical knowledge, and have had Experience with Vertical Retort Plant. Salary, £3 per Week.

Applications, stating Age and Experience, together with *copies* of Testimonials, to be lodged not later than the 2nd of October, 1928, with H. A. AITKEN, General Manager, GAS WORKS, LEVEN, FIFE.

A GAS-WORKS on the South Coast, contemplating Considerable Extensions to Plant, require in their Drawing Office, for about two years, a thoroughly reliable DRAUGHTSMAN. One with Contractors' Experience preferred.

Applicant will be required to act as Clerk of Works during the Erection of the New Plant.

Write, stating Age, Experience, Salary required, and also enclosing *copies* only of References, to No. 7887, "GAS JOURNAL," 11, BOLT COURT, FLEET STREET, E.C. 4.